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ABSTRACT

To explore varying institutional responses to the structural problems involved in university-industry linkages, the International Institute for Educational Planning conducted case-study research during 1997 to 1999 and then held a Policy Forum to share and validate the insights gained from the projects. The Forum showed that one of the most important challenges for institutional policymakers is defining a legal framework and incentive systems that stimulate entrepreneurship at the institutional, departmental, or individual levels, while designing rules and regulations through which potentially perverse effects can be avoided. The papers from the Forum are: (1) "Trends in the Management of University-Industry Linkages: What Challenges Are Ahead?" (Gudmun Hernes and Michaela Martin); (2) "In What Way Do Changing University-Industry Relations Affect Academic Activities within Higher Education Institutions?" (Guilherme Ary Plonski); (3) "In What Way Do Changing University-Industry Relations Affect the Management of Higher Education Institutions?" (Michael Lewis Shattock); (4) "Organizational Responses: The Management of Interfaces. Experiences from the Hebrew University Jerusalem, Israel" (Moshe Vigdor); and (5) "Intellectual Property Rights and Rules on Conflict of Interest. Experiences from University College London" (Jeffrey Skinner). Also included are notes relating to the discussion of the working group sessions. Two appendixes present the program and list the participants in the Forum. (SLD)

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IIEP observation programme

Policy Forum No. 11

Management of university-industry linkages

Results from the Policy Forum held at the IIEP Paris, 1-2 June 2000

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Policy Forum No. 11

Management of university-industry linkages

Proceedings of the Policy Forum held at the IIEP Paris, 1-2 June 2000

Gudmund Hernes and Michaela Martin

International Institute for Educational Planning

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SUMMARY

Within the context of knowledge-intensive societies, university-industry linkages have become very prominent on the agenda of higher education policy-making, both at the national and institutional levels. Governments are increasingly acknowledging the importance of higher education institutions as strategic actors in national and regional economic development, given their potential to upgrade knowledge of the labour force and to contribute to product and process innovation through technology transfer. As a result of increased financial stringency, higher education institutions themselves have become very keen on developing relations with industry and business.

Structural problems to be faced by higher education institutions, in the above-mentioned environment, in developing and sustaining linkages with business and industry are similar in most countries. Yet the responses to these problems vary from one country to the other and also among institutions.

In order to explore varying institutional responses to the structural problems involved in university-industry linkages, the IIEP conducted case-study research during a period from 1997 to 1999, after which was organized a Policy Forum, held from 1 to 2 June 2000, in order to share and validate the insights gained under the previous research phase. The target audience of the Policy Forum consisted of high-level decision-makers in ministries of education and higher education institutions as well as representatives from international organizations, such as UNESCO and OECD, in charge of research or operational activities in this domain.

The Policy Forum was centred on several institutional experiences from Brazil, Israel and the UK, enabling insights into the current impact and challenges of university-industry linkages with regard to academic activities, as well as within the management domain. Institutional responses, in terms of organizational development to provide support structures and policies adopted in the area of intellectual property and conflicts of interest, formed a second angle of analysis.

The Policy Forum showed that one of the most important challenges for institutional policy-makers is defining a legal framework and incentive systems which stimulate entrepreneurship at the institutional, departmental or individual levels, while designing rules and regulations through which the potentially perverse effects, such as the above-mentioned, can be avoided. A balance obviously depends on particular university culture and tradition, as well as on existing outside opportunities for collaboration.

The Forum also brought to light the fact that policy-makers respond to existing challenges in various ways, through the setting up of new structures and processes, of various natures. It appeared that many are still in the stage of local experimentation, whereas others have already adopted policies that are considered the best practice.

Such a code of best practice, to which this Policy Forum tried to contribute, is associated with the prevailing understanding of the 'university' concept, particularly in a context of diversifying higher education systems and wider competition. Institutions wishing to be considered as universities will have to show concern for maintaining some commonality of tradition and cultural values.

ABBREVIATIONS

BER/BKS	Development Banks Division
BITS	Birla Institute of Technology and Science
BUVAK	Bogaziçi University Foundation
CECAE	Executive Co-ordination for University Co-operation
CIT	Centre for Technology Innovation (at UNAM)
CYCOOP	Ibero-American Network of Industry-University Co-operation Management
CYTED	Ciencia y Technología para el Desarrollo
DSTI	Division of Science, Technology and Industry
FAPESP	Governmental S&T Funding Agency
FINEP	Financing Agency of Studies and Projects
GDP	Gross Domestic Product
GNP	Gross National Product
HEA	Higher Education Act
HEDC	Higher Education in Developing Countries
HEI	Higher Education Institution
HEP/CHE	Unit for World Conference on Higher Education
HEP/IUC	Section for Inter-University Co-operation
HoD	Head of Department
HUJ	Hebrew University of Jerusalem
ILO	Industrial Liaison Officers
IMHE	Institutional Management Higher Education
IP	Intellectual Property
IPR	Intellectual Property Rights
ISCED	International Standard Classification of Education
IT	Information Technology
MBA	Master of Business Administration
MD	Management Development
NGOs	Non-Governmental Organization
NIS	National Innovation Systems
PITE	Partnership for Technology Innovation

PNG	Papua New Guinea
PNGUT	Papua New Guinea University of Technology
PROTEU	Training programme for developing competencies for university-industry co-operation managers
R&D	Research and Development
S&T	Science and Technology
SAIC	Support structures for industrial and commercial activities SC/EST Engineering and Technology Division
SC/PAO	Division for Science, Policy Analysis and Operational Activities
SEBRAE	Brazilian Micro and Small Company Support Service
SMART	Small Merit Reward for Research and Technology
SMEs	Small and Medium Enterprises
SRL	Stanford Rooke Ltd
SUT	Suranaree University of Technology
TECO	Technology Consults Ltd (Makerere University)
TLO	Technology Licensing Office
TT	Technology Transfer
TTO	Technology Transfer Office
UCL	University College of London
UCLv	University College of London Ventures
UCSF	University Challenge Seed Fund
UDC	Unitech Development and Consultancy Pty Ltd
UNAM	Autonomous National University of Mexico
USP	University of São Paulo
USP^{MR}	University of São Paulo Dial Technology
USP^{TM}	University of São Paulo Disk Technology
VAT	Value Added Tax
VC	Venture Capital
WARF	Wisconsin Alumni Research Foundation
WB	World Bank
YISSUM	Research Development Company of the Hebrew University of Jerusalem

INTRODUCTION TO THE PROCEEDINGS

by Gudmund Hernes and Michaela Martin

Background

The difference between a lead pencil and a ballpoint pen is the amount of knowledge required in their manufacture. The making of the latter requires scientific knowledge concerning different types of alloys, liquid ink and plastics - as well as ergonomic data in order to give it a shape that fits well in one's hand. The difference between an old-fashioned typewriter and a PC is also the amount of knowledge invested into it. A typewriter is a marvellous mechanical contraption, but a PC calls for much more than an input of knowledge about keyboard layout. It needs information about the binary number system, compressing transistors on a silicon chip, liquid crystal technology, programming languages, etc. In both of the above-mentioned examples (the ballpoint pen and the PC) much of the knowledge that went into these omnipresent products originated from a university - even if some of the essential components, such as for the MS-DOS system, had been elaborated by university 'drop-outs'.

As advanced knowledge becomes an ever more important ingredient in new products and services - indeed, it is what makes them new - the focus on university-industry linkages has become more and more prominent. One of the most potent legends of the twentieth century - that of Silicon Valley - is precisely a very successful manifestation of the new relationship that may be forged between a university and its industrial environment. Microsoft and other modern companies call their sites 'campus'; while at Stanford, new buildings are named after donors, such as the William Gates

Center for Information Sciences or the Paul Allen Center for Integrated Systems.

Hence, the issue of university-industry linkages has also become very prominent on the agenda of ***higher education policy-making***, both at national and institutional levels. Within the context of knowledge-intensive economies, governments are more disposed to acknowledging the importance of higher education institutions as strategic actors in both national and regional economic development, given their potential to upgrade skills and knowledge of the labour force and their contribution to producing and processing innovation through technology transfer. Universities can enhance the value of products in the form of knowledge – industry can augment the university's value in the form of funds. Yet, alliances may not be pure win-win relations – indeed, some of the blessings are mixed.

In many countries, governments tend to allocate economic resources more selectively, with far more confined purposes and to specified outcomes. At the same time, more and more countries are providing incentive schemes, such as matching funds, seed money or tax exemptions for the development of university-industry linkages, both in the teaching and research domains. The co-existence of reduced core funding from governments with more targeted incentive schemes provides very strong motivation for institutions to enter into university-industry linkages. As a result, higher education institutions themselves tend to be less hesitant in collaborating with industry and business, due to their potential to tap non-traditional sources of funding.

In addition, patterns for the conduct of R&D in science and technology have widely changed. The distinction between basic and applied research has become blurred, as have institutional boundaries

and public and private research structures. More and more research is now of an interdisciplinary nature and draws on networks of researchers located inside and outside higher education. Enhanced expectations of the economic pay-off, due to R&D results, have also considerably influenced the attitude of institutional stakeholders, such as institutional managers and academic staff, towards collaboration with industrial partners, in particular in fields such as bio-technology, medicine and software development.

The ***structural problems***, which higher education institutions face in this new environment in developing and sustaining linkages with business and industry, are similar in most countries. Indeed, caught between economic stringency and impressive opportunity for individual and collective scientific entrepreneurship, university-industry linkages may provoke a number of ***unintended effects***, over and beyond the expected and uncontested benefits, both in the creation and dissemination of knowledge and the generation of income. Such unintended effects are:

- possible distortions of research and training agendas;
- potential diversion of energy and commitment of individual staff who are involved in interaction with industry, away from core activities, in particular in the area of undergraduate teaching;
- open communication and publication;
- growing internal fragmentation and conflicts of interest among different groups within higher education institutions or with the public interest in general.

Responses to avoid these unintended effects have to be found both at the institutional and national levels and will vary from one country to the other, as well as among institutions.

Caught by their own success

The unintended effects of university-industry linkages have much to do with changing motivation systems within academia.

A motivation system is a social arrangement to promote defined goals by encouraging specific people to behave in specified ways. This system is set up to reward them if the goals are achieved. Its aim is to guide choices and give direction so that the measures taken and their combined effects achieve as closely as possible what is desired.

The problem with establishing a motivation system is that it may be perverted: the rewards established might spur people to undermine the system. For example, Adam Smith argued that a system of justice would be harmed if judges were to be paid by the parties concerned by a conflict.

Its new links to industry generate structural problems for the university's traditional system of motivation. According to the tradition established by Karl Wilhelm von Humbolt, at the beginning of the nineteenth century, the activities of a university were to be based on three principles of freedom: freedom to study according to inclination, freedom to teach according to conviction, and freedom to do research according to interest. Such an arrangement would not only foster originality of thought, but would also provide the structural basis for intellectual independence and mutual criticism among professional colleagues. The rewards for professors were threefold: decent salaries as professionals (often public servants), acclaim from inspired students, and esteem for their contribution to original research. The latter is strongly illustrated by the naming

of theorems after mathematicians (e.g. Abel), laws after physicists (e.g. Archimedes), or diseases after doctors (e.g. Alzheimer). Another illustration is the Nobel Prize, awarded to those making the most fundamental contributions.

Not only do esteem and public recognition encourage original thinking and research, but they also persuade specialists to make their best ideas available to others. Nonetheless, convincing people to freely publicize their most inspired concepts is a persistent problem. Revealing their discoveries may entail rendering power; it may mean a loss if others siphon inventors' ideas and present them as their own, thus depriving them of honour that is rightly theirs. However, there are strong academic norms as to how contributions to the public good and in the public domain should be made known ('publish or perish') and the opposite negative procedure is highly sanctioned. There are strong imperatives to identify and quote those whose ideas are used and taboos are vehement towards plagiarism or falsification.

In short, by rewarding academics through freedom, fame and footnotes, a motivation system is set up to encourage intelligent people to come up with new ideas and interpretations, as well as to teach and train students. The system does not always work: academics may steal each other's ideas, neglect students or use their freedom and tenure for petty infighting. However, the system has worked fairly well on the whole. One measure of its success is the extent to which ideas generated at universities have been put to practical use. The first important mobilization of the academia for practical ends took place during wartime - professors were mustered in everything from the use of radar to decrypting secret codes. In the last quarter century, the success in transforming research into new goods and services has become more and more pronounced, in every possible realm, from new vaccines to macroeconomic models.

This is what has generated a new type of university-industry relations, and it is this change in relationship that now threatens important aspects of the traditional motivation system and norms of behaviour at universities: the pursuit of knowledge for its own sake, the imperative to make new ideas public quickly, the preference for footnotes over profits, etc. It can be said that the threat posed to the universities by their very success in generating new and useful ideas was one of the main issues debated in the Policy Forum organized by IIEP. It is, indeed, an example of unintended consequences.

Objectives of the Policy Forum

In order to explore varying institutional responses to the challenges and structural problems resulting from closer university-industry linkages, the IIEP took two initiatives.

- First, the Institute conducted a research project from 1997 to 1999. Managers from twelve higher education institutions in Europe, Africa, Asia and Latin America were invited to document their experience and innovative practices initiated by them towards management in the following domains:

  - interfaces;
  - financial and personnel management;
  - management of intellectual property rights in carrying out co-operative programmes with business and industry.

This research allowed the IIEP to identify current issues and available options in the management of university-industry relations.

- Secondly, the Policy Forum on the Management of University-Industry Linkages was organized with the objective to disseminate and validate the findings from the above-mentioned case-study research for a selected number of policy-makers, at both national

and institutional levels, as well as from industrialized and developing countries. The more detailed objectives of the Policy Forum were the following:

- consolidate the identification of current issues and challenges with respect to the management of university-industry relations;
- share experience acquired among experts, as well as the insight gathered from case studies that had been conducted within the framework of the IIEP research project, with those in charge of national and institutional policy design and implementation in the area of university-industry linkages;
- develop recommendations for the design and implementation of national and institutional policies, whether they with a view to defining an appropriate framework for financial management of extra-budgetary funds, intellectual property rights or for organizational development (i.e. interfaces).

Since both ministries and higher education institutions must deal with problems in industrialized and developing countries, and since the nature of institutional responses varies, it was thought to be possible, and deemed desirable, to exchange experiences at equal levels and to establish bilateral links between ministries of education and higher education institutions in different development contexts. It was especially expected that a dialogue between institutional managers and policy-makers would contribute to better identifying problems faced at the grass roots, as well as to engaging a policy option, at the national level, with greater relevance to the complex reality in which higher education institutions are currently operating.

A further intention was that the sharing of insight, gained both through the IIEP research project and on the basis of the participants' individual experience, would lead to the establishment of guidelines for policy, which concern the issues mentioned below (problems and

possible organizational responses) in view of their adaptation by ministries of education or higher education institutions. This report synthesizes the discussions of issues and policy recommendations, which should be implemented at both national and institutional levels.

Forum organization

The target audience of the Forum was high-level decision-makers in ministries of education and research, and policy-makers and managers of university-industry linkages within higher education institutions. The selection of participants depended on the specific policy-making framework of each country, in particular in the distribution of authority for policy-making in the area of university-industry linkages. Participants were invited from Europe, North and Latin America, Asia and Africa. In addition, the Forum brought together several representatives from UNESCO and OECD who have done extensive work in the domain of university-industry linkages, in both research and operational activities.

The number of participants was limited to 30, which would allow for more in-depth reflection and discussion (see *Appendix 2: List of Participants*).

The meeting was centred on:

- a presentation of the findings of the IIEP case-study research on the management of university-industry linkages;
- four plenary presentations on selected issues;
- two working group sessions;
- a panel discussion on "*How to create an enabling environment for*

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the development of university-industry linkages" (see *Appendix 1: Programme*).

In addition, the programme allowed for quite an intensive exchange of views and experiences after each presentation.

Identification of issues: in terms of the impact of the changing of university-industry relations on higher education institutions

The IIEP case-study research of institutional experiences, synthesized in Gudmund Hernes' and Michaela Martin's contribution, has highlighted that the present status of university-industry partnerships is a relatively new phenomenon, observed during the past three decades, in most industrialized and developing countries. Under the influence of the above-mentioned external pressures, such partnerships have strongly expanded in scope, number and degree of institutionalization. University-industry linkages cover a range of diverse realities, in both teaching and research, such as student placement schemes, staff exchanges, consultancy services, continuing professional development, joint R&D, as well as in small enterprise development and the creation of spin-off enterprises for the joint commercialization of R&D products.

It was underlined, during the Policy Forum, that university-industry relations comprise a wide range of very different formats. At one end of the spectrum, ivy-league type higher education institutions may be linked to major high-tech corporations for multi-year joint R&D. At the other end, however, a small, regional university may collaborate with a small company. It may provide technical assistance in the upgrading of existing low-level technology and management techniques, or offer continuous education programmes with a view to upgrading professional competences. In industrialized countries, research-related university-industry linkages are quite frequent,

whereas consultances, student placements and continuous professional development would be the favoured type of linkages in many developing countries.

The level of development and the focus of university-industry linkages depend on a number of boundary conditions, in particular on:

- research and teaching capacity found within higher education institutions and industry (foremost, but not exclusively, in technological, scientific and managerial areas);
- an industrial base (e.g. multinationals and, to a lesser extent, small and medium-sized industry) involved in R&D activities and concerned with staff development;
- a traditional interaction practised between higher education and enterprises;
- an entrepreneurial culture within the higher education sector.

These boundary conditions shape the particular profile that interactions take. The existence of outward-looking academic staff with experience in both industry and academia is another factor which may facilitate, just as it may hinder, the development of joint activities.

In their contribution, Hernes and Martin emphasize the fact that, whatever their former level of development and degree of institutionalization, university-industry linkages are changing in scope and nature within the context of ongoing globalization, growing economic interdependence and increasing reliance on market-based approaches.

One of the objectives of the Policy Forum was to identify issues and problems posed by the changing nature of university-industry linkages. This was done with regard to two realms of activities: academic and management.

Identifying impacts in terms of academic activities

In many institutions of higher education, the changing nature of university-industry linkages heavily affects both research and teaching activities. Ary Plonski confirms that, in Brazil, the nature and the type of research in most higher education institutions are also currently experiencing a shift from a 'pure', or basic, to a more applied type of research. Funding patterns for research are also changing. As in most OECD countries, the level of public funding for research is declining, is often specifically geared towards research in the realms of life sciences and technology, but also in other applied fields. Moreover, there is an increase in the provision of funding from private business to R&D in universities. In other words, public funding allocated to research tends to be concentrated in specific areas and has become more outcome-oriented. Many special programmes, developed over the past decade, have provided matching funds for research that was jointly conducted by universities and businesses. Consequently, the research agenda of the University of São Paulo (USP) has been greatly affected by the changing nature of university-industry linkages.

With regard to the teaching, both undergraduate and graduate teaching are affected by university-industry linkages at USP. In addition, a new function is arising in the teaching domain, *viz.* continuous professional development. Very interesting initiatives have been taken in undergraduate teaching at the University of São Paulo, where a consortium comprising representatives from several enterprises and university staff has been formed in favour of the joint revision of the undergraduate curriculum, in particular in the

technology area. 'Internships' are a traditional, but changing, modality. At the Faculty of Engineering of USP, students increasingly tend to do their internship in the SME sector, where their impact can be more direct, and where technology needs are of a less complex nature, compared to those found within larger companies. As a consequence, internships in SMEs can provide fruitful experience for students.

As far as the teaching of graduate students is concerned, the topics for Ph.D. theses, again particularly in technology fields, seem to be increasingly determined by research grants provided from private enterprises. This often poses a problem with regard to open communication, since results gained from sponsored research may entail obligations for secrecy, at least for a given period of time. In addition, a number of professionalized master degrees have been set up at USP that tend to specialize students too early. The more they are trained specifically to solve the problems of an industrial branch, the less adaptable they may become for a broader range of problems.

University-industry relations certainly increase the relevance of provision for teaching/research, but they also generate numerous conflicts, such as competition for faculty and students' time-disposal. They may also increase fragmentation within the university, where some units benefit intellectually and financially from the links, whereas others obtain neither the links nor the benefits. With increasing interaction with industry, there is, furthermore, a growing risk that academics, especially young postgraduates, leave the university, seeking more interesting and lucrative appointments in industry.

A newly arising phenomenon within this changing context for university-industry linkages is academic entrepreneurship: individual researchers become increasingly involved, as individuals or in conjunction with their university, with the commercialization of their research results, through licensing a patent or by the creation of a

spin-off company. Such academic entrepreneurship creates supplementary challenges and need for policy response, many of which concern the way to make the best institutional use of the double role, i.e. academic and entrepreneur, which some staff will increasingly play. Carl Lindberg, Deputy State Secretary of the Swedish Ministry of Education, mentions these challenges in his discussion paper on Ary Plonski's contribution.

▩ Issues raised during the discussion

- How to balance public interest with increasing commercialization of university processes and products?

- How to balance the need for growing entrepreneurship and at the same time protect the intrinsic values of higher education, such as interest-free research, critical reflection, open communication and the stimulation of open debate on research results inside and outside higher education?

- What is the most appropriate legislative framework for the granting of intellectual property rights, that favours rapid technology transfer into the economy?

- How to reconcile the legitimate interests for Ph.D. students to publish with the obligation of secrecy?

- If companies become involved with curriculum development, how to avoid a too narrow specialization and the need for training to acquire adaptability, as opposed to a specific job profile?

- How to avoid conflicts of interest in initial training and continuing education, and how to create beneficial interaction between them?

- What rules should be put in place to regulate outside work by

academics and how can one create the transparency which is necessary to monitor outside commitments?

- What policies should be developed with regard to the equipment acquired in a university-industry project? Should the rule be that equipment must remain the property of the university department once the project is over?

- What types of new quality assurance procedures have to be developed for joint projects in teaching and research? Who should judge and what are the most promising topics and methodologies?

▩ Identifying impacts in terms of management

The changing context for university-industry linkages, within both developed and developing countries, is a challenge to existing structures and procedures for the management of university-industry linkages. Michael Shattock, former registrar of the University of Warwick, points out in his contribution that the more traditional administrative structure for the management of university-industry linkages has been the industrial liaison office. Such an office tended to be staffed with one liaison officer mainly in charge of linking up with surrounding enterprises, facilitating contact, and providing administrative back-up for joint projects. Similar monolithic structures were set up for the support of continuing education or technology transfer. In many universities, offices for the support of continuing education or technology transfer were set up in the central administration and their task was to provide administrative assistance in the marketing of continuing education or R&D results.

The growing number of university-industry linkages and their functional diversification calls for more complex structures and procedures. The most obvious manifestation of this is the setting up

of a diversified body of support structures, such as science parks, incubator facilities, exploitation or trading companies, etc. With the provision of major funds for R&D from supranational funding sources for R&D, many universities also tend to set up external offices, e.g. European Offices, to channel information on funding opportunities and to help develop proposals. Support structures or interfaces tend, usually, to concentrate on either the teaching or research function. Some specialized structures are set up with the explicit objective of commercializing university products; others, such as incubators or science parks, are more directly geared to enterprise development.

In addition to the development of interface structures, the financial management of university-industry linkages receives increasing attention. A question of crucial importance is how to identify the full cost of a project, and how to distribute the overhead provision among the different participating entities (researcher/team, department/university).

The determination of overhead charges for joint ventures in the research domain is mentioned as being a major problem for universities in Michael Shattock's paper. Such overhead charges vary considerably from one institution to the other and even within institutions. This indicates that they are not based on real cost patterns, but often decided on political grounds. In some institutions, they can be higher than 100 per cent of the base cost (Warwick University is an example of an institution applying such overhead rate for research contracts in science and technology). However, in most institutions the overhead values are in the order of 40 to 30 per cent. The overhead provision is generally much higher when work is laboratory-based since expensive equipment is then extensively used.

Overheads to be charged to a charitable or another public funding and those to be charged to a commercial enterprise are generally different. There is common agreement that overheads for a publicly funded research project may be lower than those charged for a project carried out for a commercial enterprise; the latter, as a general rule, is required to carry full-cost investment.

Universities may pursue different objectives in their linkages to industry. If they are financed by a charitable body, they may decide, or sometimes be obliged, to charge lower than full-cost overhead provisions or to waive them altogether. They should, however, be clearly aware they are doing this, and be able to evaluate the possible financial loss and risk taken. It is, consequently, imperative to determine as precisely as possible the indirect cost of an external venture. This may be done in-house, but sometimes it might be helpful to request an external agency to make an in-depth analysis of cost structures and to propose a flat overhead provision that will be charged to projects.

Another major concern for a university is how to reach an internal agreement on overhead and its distribution among the departments, university and perhaps with the individual researcher. There is fundamental tension between administrators, who are in favour of high overhead, and the academics who have a marked preference for low overhead – the latter fear that high rates may create a barrier in the negotiation of a research contract funded by private sources and the former are also concerned with maximization of profits.

Another issue mentioned in Michael Shattock's contribution is the importance of discretionary funding or venture capital arrangements. This issue becomes increasingly important within the context of growing potential for research-related university-industry linkages and the entrepreneurial university. It is in particular through

the commercialization of R&D results, that discretionary funding, or capital, is becoming a prerequisite for bringing R&D results up to a patentable stage or to bridge the gap between an invention and its commercialization through licensing or enterprise creation. Such commercialization often entails further development as well as an extension of the testing phase. In addition, the early stages of commercialization of R&D results need considerable pre-investment, often over a period of several years. If there are no provisions for seed money at the national level, venture capital funds may be provided at the institutional level. However, in a context where national legislation allows institutions to do so, an appropriate support structure, such as a technology transfer office, may also develop links with private venture capitalists that may have an interest-investment in a promising R&D result.

Michael Shattock's contribution refers to the issue of staff motivation. Systems through which university staff can be motivated to commit themselves to university-industry linkages tend to take a different meaning within the new context for university-industry linkages outlined above. Governments increasingly provide targeted research funds, which present strong external incentives to remain within the mainstream of proposed research domains and to promote collaboration within university-industry networks. In addition, the potential economic pay-off from medical, pharmaceutical and bio-technological research pushes academic staff to collaborate with industrial research laboratories. In such a context, the extrinsic motivation is becoming stronger than any institutional rule. It should, however, be noted that such strong extrinsic motivation systems are limited to certain disciplines only. Many other research fields still tend to function in a more traditional set-up, with regard to both funding patterns and expected pay-off of research results. Here institutional motivation systems, such as a change in promotion criteria and financial reward may be a necessary signal that an

institution values commitment to university-industry linkages, which may be an indispensable ingredient for a change in the organizational culture of an institution.

In his commentary on Michael Shattock's paper from the Norwegian experience, Trond Fevolden, from the Norwegian Ministry of Education and Church Affairs, focuses on the importance of the national background. He mentions in particular overall national funding mechanisms for R&D, for instance, the creation in Norway of a fund for research and innovation and special tax incentives which stimulate university-industry linkages. Proposals are under way to reform the governance of Norwegian universities and to adopt a law that should facilitate the commercialization of R&D results by universities.

In addition to the above-mentioned challenges at the institutional level and some actions taken by governments at the national level, the Policy Forum identified the following questions on crucial policy issues, i.e. in the management domain:

- to what extent is it possible/desirable to attempt to co-ordinate or develop university-wide policies for university-industry linkages, given the intrinsically bottom-up nature of joint ventures?

- while responding to the necessity for providing appropriate support structures for the diverse functions of the management of university-industry linkages, how can one avoid breeding bureaucracy?

- what level of financial and managerial devolution is more appropriate for the management of university-industry linkages, again given their bottom-heavy nature?

- if financial and managerial authority is decentralized, what types of competences and skills have to be developed by deans and heads of department to enable them to cope with new roles in the management of university-industry linkages?

- how can one set up an accounting system capable of determining appropriate overheads for collaborative research?

- should an institution unveil the details in the determination of overhead (in view of transparency) when negotiating contracts, or is such transparency only necessary for internal purposes?

Identification of policy responses: what is at stake and what can be done?

The following section accounts for the organizational responses that were discussed during the Policy Forum, in an attempt to assist the Institution in the formulation of an answer to the challenges identified in *Parts II and III*.

▩ Identification of policy responses in terms of interface development

Both Michael Shattock and Moshe Vigdor discuss the more diverse support structures that are currently being set up in universities worldwide, both internally and externally, due to the growing diversity of university-industry linkages.

Moshe Vigdor's paper presents a successful organizational model of this type of support structure - YISSUM, a wholly owned subsidiary of the Hebrew University of Jerusalem (HUJ). YISSUM is a 'not for profit organization', its aim being to fully manage all research-related relations with industry, e.g. with respect to contract negotiation, patenting, licensing, venture capital and the development

and management of spin-off companies. YISSUM is an external interface, i.e. a separate legal entity from HUJ. This independent legal status allows YISSUM to both protect the university from undue external interference and to obtain managerial flexibility in the daily running of operations and projects.

YISSUM is directly controlled by HUJ according to a very clear set of rules and regulations. They define the responsibilities of each entity in order to make sure that the interface remains in the mainline of university policy and avoids possible conflict or competition with other internal decision-making bodies of HUJ.

In addition to YISSUM, HUJ has set up another consistent body of rules and regulations. It defines the university's policy in the area of university-industry linkages and through this HUJ aims to avoid potential pitfalls. Such rules and regulations refer to the maximum time a researcher can afford to spend on external activities. They incorporate an obligation for the disclosure of outside economic interests and of potentially commercial interest. YISSUM is entrusted with the follow-up on these statements of disclosure.

Given the fact that all intellectual property rights of R&D results remain directly within the university, YISSUM is the only university entity that is in charge of the commercialization of R&D and technical services. In addition, the university applies a very strict policy with regard to business involvement of researchers. They are not allowed to conduct research financed by a business in which they have a stake and their equity stake in a business may not exceed 10 per cent.

The development of start-ups has recently been gaining importance at YISSUM, which has set up a venture capital fund of US$7 million to provide funding for commercially promising R&D results.

YISSUM, together with clear-cut policies and regulations of the Hebrew University of Jerusalem, was presented as a successful organizational framework for the management of research-based university-industry linkages. It was underlined, however, that a well-developed science and technology base, in addition to the availability of a great amount of exploitable research, are *sine qua non* conditions for a successful running of any interface.

Knud Larsen, of the Danish Ministry of Research, discusses the experience of YISSUM in interface development, from his country's experience, which is characterized by strong ministerial co-ordination. Again within a context of blurring boundaries between basic and applied, or public and private, research and the growing importance of information technology and biotechnology, the Danish Ministry for Research has been concerned with management reform of technical universities and the development of incubators. Pooling of technological capacity has been accomplished through a cross-country merger of scientific departments within a given region, which also involves the private sector. The Danish example strongly demonstrates that the state can play a very strong role in structural reform, especially in the case of merger of institutions, or cluster formation, for the pooling of research capacity at the regional level.

The discussion focused on the following issues:

- how can interfaces best be controlled by their alma mater?
- how can conflicts of interest between other bodies and the interface be avoided?
- what types of instruments should be developed through which the interface can bear a financial risk without committing the university?

- how can an interface best develop trust among the academic community, which tends to be hostile to university-wide rules and regulations as well as administrative red tape?

Identification of policy response in terms of intellectual property rights

Jeff Skinner presents the experience of the United Kingdom in general and the example of the University College of London in particular. He confirms that higher education institutions, with strong potential in technology and life sciences, are more and more concerned with intellectual property rights and their exploitation. With this in view, legislation at the national level - or policy at the institutional level - as to whom the intellectual property rights should be granted (to the institution, researcher or enterprise) has been effectively adopted in many cases. There is a trend towards an increasing number of patents deposited by higher education institutions.

However, a wide variety of such rules and regulations persist internationally. One variant, for instance, in France, gives freedom to institutions to establish their own rules on intellectual property. In other situations, such as in Nordic countries, in default of any other policy decision, all intellectual property goes automatically to researchers. In the UK and the USA, intellectual property belongs to the employer-organization, that is the university.

Whatever the content of legislation or policy on intellectual property rights, it was underlined that a patent does not inevitably mean that an invention will be transformed into an innovation. This is guaranteed more immediately by either a licensing arrangement or the creation of a spin-off company.

Skinner stresses that governmental officials and university administrators seek to encourage and stimulate entrepreneurial activities, but they also wish to avoid the unintended effects such as dilution of loyalty and conflicts of interest. Such problems arise particularly when academic entrepreneurs set up their own company for the commercialization of their invention, sometimes with equity owned by the university.

National legislation or institutional policies on such possible conflicts of interest vary widely internationally. In the USA, where there exists both longstanding experience in the domain of commercialization of university products, and high demand from enterprises, top-level research universities tend to institute rather strict policies relating to conflict of interests, in particular with regard to spin-offs.

Skinner presents the model of UCL Ventures (UCLv), the Technology Transfer arm of the University College of London. UCLv is responsible for filing patents, negotiating licence agreements and helping UCL spin-offs to raise investment capital. At UCL, all intellectual property, with the exception of scholarly work (books) belongs to the university.

Over the years, UCLv has developed a number of practices, rather than policies, that relate to the creation of spin-offs. These practices refer to the use of UCL facilities for university-industry linkages for which template contracts have been developed. With regard to potential conflict of interest, a researcher with a spin-off company is supposed to inform his/her head of department of such an activity. Moreover, UCLv has started to take a seat on the Board of such spin-offs. Another practice is for UCL to act as a support facility for academic entrepreneurs rather than a controlling or managing entity. Typically, it would ask from 10 to 50 per cent equity in it.

UCL has now had 10 years' experience of management and exploitation of intellectual property. Support structures (e.g. UCLv) have been instigated and restructured and a number of practices have evolved, in addition to some earlier policy decisions, although limited in number. Various issues related to spin-off companies have emerged and been dealt with in a practical manner. After this experience, the time seems to be ripe at UCL for the development of more clear-cut policies, similar to those which have been developed, for instance, by the Hebrew University of Jerusalem.

The presentation of UCLv was discussed by Didier Coulomb, of the French Ministry of Research, in the light of French experience in the management of intellectual property and enterprise development. His government has recently developed a new law which allows academic staff to take an equity stake in a spin-off company and which permits the establishment of research contracts between these enterprises and the researcher's laboratory. Not only may universities in France set up commercial arms, they also have access to seed money and venture capital.

Furthermore a number of problems linked to this new law exist in France. Universities are not necessarily competent in the negotiation of patents. If a spin-off entails financial risk, the head of institution may be held responsible, and the university might lose patent rights if a spin-off does not succeed.

▩ Identification of policy response in terms of financial management

University-industry linkages have various purposes, one of which is the generation of extra-budgetary funds. Such funds often allow the establishment of some room for manoeuvre, particularly when governmental core funding increasingly comes with a string attached.

However, financial imperative is not the sole source of motivation towards the development of university-industry links; there are many more.

During a working group session of the Policy Forum, it transpired that most funds in developing countries are generated through continuous professional development, mainly in technology, engineering, management and languages, as well as by consultancies. In the industrialized countries, considerable income is generated through the commercialization of R&D, in particular through licensing agreements and commissioned and joint R&D. The potential for income generation is quite variable and is a function that has many inside and outside parameters.

The issue of financial incentive was discussed at length during the Forum. The distribution of income generated from royalties and licences and through overhead provision is a crucial instrument in this respect. Most universities have developed formulae for this, which reflect their underlying conception of the place that university-industry linkages have on the policy agenda. Many institutions allow research staff to generate considerable income for motivational purposes. Others consider commitment to university-industry linkages as being part of the mainstream and the generated income mainly accrues to the institution. In many cases, such income is also reverted to an institutional or departmental development fund, often for research purposes. This in turn creates strong incentive for research teams since it produces new opportunities for future research work.

Much less common is a policy of salary increases given to those research teams that are able to attract research contracts. Again, such financial incentives prove very clearly that an institution values the fact that researchers become entrepreneurial, and offers them

opportunities for major salary increases. However, in many cases, the collegial culture of higher education institutions does not permit such a strong financial incentive system to be put into place. In many cases, institutions legally have the possibility to differentiate salaries, yet they decide *not* to do so, since it is not compatible with their prevailing institutional culture.

Risk or venture capital arrangements are also of paramount importance. In this domain, the national framework is crucial. In many industrialized countries, such as the UK and France, the state is making available seed money for inventions which are not yet capable of attracting private venture capital. If such arrangements do not exist, institutions have to set up their own venture capital funds. However, such capital needs tend to be substantial. Nonetheless, institutions are not often permitted by state regulations to set up such funds. They may not be allowed to enter into risky financial operations, nor are they able to generate the sums which are necessary for these operations. Institutions, through their technology transfer offices, provide occasional assistance to academic entrepreneurs for the attraction of venture capital funds, negotiating the terms of contracts and issues such as equity stakes in such arrangements.

Under these various arrangements, which are widely a function of the national administrative framework, the question arises: who is to bear the financial risk involved? If there are national arrangements for seed money, the national agency, or body, carries the risk. In case of institutional funds, it is of course borne by the higher education establishment.

In their financial management of university-industry linkages, institutions benefit very widely from their charitable status and tax exemption, both with regard to VAT and revenue tax. Since they are

increasingly becoming entrepreneurial in nature, this charitable status will also be questioned and it is likely that new rules with regard to the taxation of revenues will be imposed on activities truly entrepreneurial in nature and conducted with a clear purpose of income generation.

The financial management of relations with industry generates many other important questions, such as an appropriate organizational structure for financial management in general, or the issue of devolved budgeting and management in particular. Devolved budgeting and management of generated funds by the departments themselves are high on the agenda these days as a mechanism to raise ownership and cost-consciousness among those who are the main players in university-industry relations, that is the academic staff. Obviously, the more decentralized the financial management to departments, and the more autonomy given to them over deciding how to use generated surpluses, the greater the motivation for such units to engage in relations with the productive sector, since they are the direct beneficiaries of their work.

Appropriate accounting systems that enable good financial monitoring of projects are another crucial concern. Traditional accounting systems do not often manage core funding and university-industry projects separately. As a consequence, it is difficult to determine, at a certain point in time, if this relationship is profitable, since project revenues and expenditures cannot be easily compared. Accordingly, it is advisable to establish separate accounting.

▩ Identification of policy response in terms of staff management

The development of university-industry linkages depends on university staff willing and capable of entering into fruitful and long-lasting relations with enterprises. In institutions where such relations are conducted on an ad hoc or personal basis, it is particularly staff

with work experience from an industrial context who are the most active. This observation shows that knowledge of the partner's working environment and culture is a very crucial success factor for building up a productive sustainable relationship between universities and the productive sector. Other key factors are commitment and creativity of staff. Commitment may guarantee the long-term viability of linkages; creativity is necessary to keep them active.

With growing institutionalization of university-industry relations, both strategic and operational management of university-industry linkages tends to be increasingly concentrated in the hands of professional managers. Such professional managers are involved in the marketing of potential products and services. They also collaborate in the negotiation and costing of projects, in the management of intellectual property rights, and many other matters, according to the division of tasks and responsibilities adopted in an organization. The range of competences required of professional managers in university-industry relations is ever widening. As a consequence, appropriate staff recruitment and development in these domains are very important aspects of personnel management for developing university-industry relations.

Managers of university-industry relations are not the only ones to need specific competences; the same holds for the academic staff. One can easily argue that participation in a project with industry is already a type of staff development, because it allows a staff member to get involved, usually on a voluntary basis, in a practical activity related to his/her teaching and research/study activities. This is in itself a value added from collaborative projects. Institutions, however, also have to protect themselves from undesirable effects such as staff neglecting their professional duties, with regard to teaching for example. As a consequence, staff-management rules and

procedures need to give guidance as to the amount of time staff members may dedicate to projects within the private sector.

Higher education personnel in general, and academic faculty in particular, need to be part of appropriate reward and incentive systems to attract and maintain quality staff within higher education institutions. This issue pertains, of course, to the above-mentioned financial incentives created through rules for the distribution of income. Financial incentive is not, however, the only type of incentive to be deployed by higher education institutions. This was discussed during the working group session on staff management, at the time of the Policy Forum.

What is the role of different actors: governments and institutions of higher education towards the development of a checklist?

Several times in this introductory chapter we have pointed out that in the new economic environment, the problems faced by universities when they link up with industry are structurally similar - very much the same irrespective of the location of the university. The research done before IIEP's Policy Forum aimed at identifying the impact on institutions. The Policy Forum itself focused more directly on policy responses - what had been done and what can be done. This review clearly showed that though problems are much the same, the legal, organizational and management responses are widely different.

For example, the extent to which universities have established clear and detailed rules on property rights to new ideas or inventions show great variation - e.g. whether they belong to the university, the department, to the professor and his/her co-workers. Likewise, potential conflict of interest is managed in some places by rules of disclosure or on what contracts can be entered - e.g. whether a doctor

at a university hospital can take part in the scientific testing produced by a company in which he owns shares. Such examples are easily multiplied.

But in variation there is information, and in two respects. First, by example, the varied practices show a *range* of policy options – actions that *may* be taken. By knowing about others' choices and the consequences they have had, one gets vicarious experience – solutions that have been tested by practice. Copying can be cheaper than inventing; what others have learned to avoid can be less costly than making your own mistakes.

Secondly, the practices others follow show that policies are often adopted not by explicit decisions, but simply by *not* taking decisions, i.e. by default. For instance, as mentioned above, Norwegian universities have not adopted any rules on the partition of intellectual property rights to inventions made in university laboratories. However, the fact that there are no rules, does not mean that there is no policy – the policy by default is simply that the invention belongs to the professor. At most universities, when professors write textbooks, the royalty belongs to the authors. With the new possibilities for electronic transfer, lectures can be taped, sold and disseminated via the Internet. Most countries or institutions have no rules on who owns taped lectures. Stanford University has adopted the policy that they belong to the university who uses them to generate income.

To make policy decisions more considered and open, it is necessary to state explicitly what are the potential choices that can be made. We have already listed some questions after each of the sections in this chapter, but to illustrate the usefulness of making an inventory of policy questions, we have made a sample list of questions below. It is, of course, by no means exhaustive. It is meant to demonstrate not

only that different answers can be given to the questions posed - but also that *not* posing them in itself is a policy choice.

Following is a list of policy-relevant questions, which were identified in the Policy Forum.

(i) Have new arrangements been established for the promotion of university-industry linkages either by government or institutions?

- are there legal frameworks in place to promote university-industry linkages?
- have patent laws been established?
- are there established rules for the protection and sharing of intellectual property?
- is there shared understanding of 'who has the right to do what pay-offs' from ideas generated at the university which can be commercialized?
- are there existing rules for spending time on 'outside work'?
- what is in place for the costing and pricing of services?
- have special institutional arrangements been set up to promote and facilitate university-industry linkages?

⇒ *If no rules have been established, how may you justify this situation?*

⇒ *If rules have been established for the sharing of intellectual property, in what way are the returns divided between inventor/professor and institution (university/department) and investor?*

(ii) Are structures in place to facilitate contacts

- through the organization of opportunities to meet (i.e. seminars, fairs, etc.);

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- through exchange of professionals or industrial fellowships;
- through affiliation programmes;
- through memberships of representatives from the productive sector in university decision-making bodies?

By promoting university-generated ideas within industry

- through the presence of specialized staff;
- through the creation of technology liaison offices or seminar unit within the university?

To provide venture capital for start-ups

- through fora for presenting ideas to 'angels' or potential investors;
- through separate organization for the generation and receipt of income from intellectual property that can be used for supporting other initiatives;
- through special venture-capital funds on which the university or its staff may draw;
- through organized contacts with venture-capital funds?

(iii) Have measures such as the following been established towards the protection of the core functions of the university?

- Are there rules on outside engagements and conflicts of loyalty?
- Are there measures to protect the interests of students with respect to:
  - teaching guidance and mentoring;

- faculty time spent on teaching *v.* supplementing income by outside activities;
- protection of student research from being invaded by professors' outside business commitments;
- systems for monitoring the quality and integrity of teaching?

- Are there measures to protect the interest of faculty:

  - rules for managers and administrators so that they will not find themselves in conflicts of loyalty in the triangle between faculty, university and industry;
  - agreed-upon criteria for promotion and the extent to which they should reflect the outside commitments that the university encourages;
  - agreed-upon guidelines for the distribution of income generated from licences and from overheads?

- Are measures taken to protect research and the research agenda?

  - rules on rights to publish;
  - rules on the protection of open communication;
  - explicit institutional policies about the mix of basic *v.* strategic and applied research;
  - clear guidelines on patents and secrecy *v.* publicity and open communication;
  - clear guidelines on generated income regarding which parts are redistributed to research funds to provide seed money for further research activity?

(iv) Are measures taken to ease out potential internal conflicts?

- to protect fields without strong industry ties (e.g. humanities relative to medicine and computer science);

- to ensure the balance between administration and faculty;
- to ensure the balance between faculty and students?

Over income of institutions, institutes and personnel:

- do strategies exist for handling diversified income basket *v.* core funding?
- is there an agreement on who decides over the allocation of generated funds?
- are there transparent financial management procedures in place so that grey areas and grey economy pay-offs are avoided?

As can be immediately seen from this list of policy choices - indicative and, of course, incomplete - the whole area is 'politically dense', in the sense that as soon as questions are stated explicitly, a large number has to be addressed. As already underlined, *not* making choices explicit, does not mean that they are not *made* - it only means that they are made tacitly and implicitly, unstated and unspoken.

Conclusion

In the knowledge economy, the value of goods and services is not only measured by their price, but also by the amount of new knowledge they embody. More importantly, economists claim that the knowledge sector of the economy is the one responsible for the greatest contribution to growth and job creation. The corollary is then obvious: if new knowledge has a high marginal pay-off, it will draw high investments.

Moreover, capital will follow knowledge to its source, not just by emulating the social organization of universities in the amount of

research carried out within companies and in the university-style social organization. It will migrate towards universities themselves in order to obtain value for money. There is a sense in which this recent phenomenon illustrates the success of an organization. Indeed, universities have been placed among the most successful institutions, their origins being traced back to over a millennium.

The success in drawing attention and funds may be presented as a 'blessing in disguise': universities are becoming attractive because knowledge is economic power. It may be considered to be a mixed blessing: economic power influences the mode of producing knowledge at university level and may change the very nature of universities. To take but one example: firms financing a project which provides important funds, even though at the margin, may be able to control professors' time and university equipment, worth many times its marginal cost – the 'tail may begin to wag the dog'.

Hence, universities are under influence, the problems they face are much the same irrespective of their location, and even though they are structural and quite similar, the responses to them are so far in no way alike. There are great variations in the extent to which new functions have led to structural differentiation, opportunities for profit – i.e. rules and regulations on intellectual property – claims on time and allegiance, leading to regimenting interest and loyalty conflicts.

For policy-planners and makers, what results is not always the outcome of close observation, tight analysis of implications or review of realistic alternatives. Politics is often something that happens by default – policy-makers are rarely policy-takers. They tend to accept 'what comes about' rather than what is decided on.

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If policy-making is to be better informed and choices more judicious, three things are needed:

- a review of the situation – the forces that are at work, the effects they are likely to produce and the problems they are likely to generate;
- a menu of a possible course of action;
- a review of the 'pros and cons' of the various options.

It is for these three purposes that both research and policy are useful. By input from research and by dialogue from hands-on experience, it is possible to review and assess trends that are emerging. By comparing what ***has been*** done through the natural experiments of different responses, it is possible to establish what *can* be done. Furthermore, by reviewing the reasons for their choices and then by having highly informed actors discuss relative merits and potential consequences within different social systems, countries may draw from a pool of experience, not necessarily available at 'home base'.

The purpose of policy analysis is to identify what is worth pursuing, what has been done and where, why and with what results, in order to more coherently determine what should be envisaged thereafter. The purpose of this report is to contribute to such a process.

Summary

Table 1 – Issues, policy objectives and action at the national and institutional levels

Issue	Policy objective	Action at the national level	Action at the institutional level
Administrative support structures (interfaces)	Back up emergent initiatives in the area of continuing education, commercialization of consultancies, R&D through adequate support structures	Provide incentive funds or creation of posts to staff such structures Define regulatory mechanisms for the setting up of subsidiaries or commercial enterprises (profit or not for profit) owned totally or partially by the university Define regulatory mechanisms with regard to the taxation of such subsidiaries (VAT, revenue tax, etc.)	Opt for appropriate legal status of (internal or external) interface (for profit, not for profit) Define internal statutes and rules and regulations with regard to its control by the alma mater Set up informal control mechanisms through participation in governance structures of the interface Define internal structuring in accordance with university culture (centralized/decentralized) Identify staff competences needed and recruitment/ development in the light of posts created or extra-budgetary funds available
Financial management	Provide necessary financial autonomy to HEIs to manage their relations with industry flexibly	In countries with public accounting systems, establish specific accounts for projects under university-industry linkages Establish regulatory framework allowing institutions/departments to maintain generated income (without deduction in core funding!)	Develop competency (full costing with provision for depreciation and analytical accounting), with regard to the management of such specific accounts Introduce systems of devolved budgeting (cost and profit centres) whereby basic units become responsible and maintain the generated income at at the departmental level

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Issue	Policy objective	Action at the national level	Action at the institutional level
			Develop policy with regard to the pricing of specific services (market price/full cost) Establish institutional guidelines for overhead to be charged to R&D projects (laboratory based or not), avoiding contractual negotiations
Resources and financial incentives	Provide necessary resources for university-industry linkages	Provide matching funds channelled through research bodies for joint R&Dprojects, national or international research consortia, or the setting upof research centres within universities Provide matching funds and national support structures for SME development (joint establishment of research agendas) Provide tax incentives or soft loans for R&D expenditure by private enterprises channelled entirely or partially to universities	Develop institutional risk/ venture capital fund from generated income
Staff management	Motivate staff to commit themselves to university-industry linkages	Revise personnel statutes to take account of staff involvement in continuing education, consultancy or technology transfer activities	Revise procedures and internal rules with regard to staff promotion Devise guidelines with regard to the distribution of generated income from surpluses Develop financial incentives (such as salary surpluses) for those staff which attract

Issue	Policy objective	Action at the national level	Action at the institutional level
			contracts from industry Provide material incentives such as preferential access to travel grants, equipment, etc.
		Provide a legislative framework for the employment conditions of contracted staff by public institution	Develop policies for equal treatment (employment conditions and staff development opportunities) of contractual and fixed-term staff
Intellectual property rights	Avoid conflicts over IPR within institutions and in contractual negotiation	Design national regulatory framework with regard to ownership of intellectual property rights (HEI, industry, individual researcher) from publicly or privately sponsored research	Design institutional rules with regard to ownership of IPR (university, laboratory, individual researcher or enterprise) Put in place operational capacity to detect the potential of an R&D product to be published
Commercialization of R&D products	Speed up the gap from invention to application and generate income	Design national regulatory framework allowing university researchers to set up their own enterprises, to have equities in them or to set up governance structures	Put in place incubators and science parks (jointly with local/regional/national authorities)
Protection of mainstream activities	Avoid diversion of energy and distortion of the research agenda	Specify professional obligations in personnel statutes	Specify professional obligations in employment contract Develop guidelines or rules with regard to the maximum time allowed for outside activities as well as obligation to inform head of department of such regular outside commitments Put in place a management and control capacity at the departmental level

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Issue	Policy objective	Action at the national level	Action at the institutional level
			Aim at a diversification of funding sources
Open communication and publication	Protect open communication and the right to publish		Design rules which prohibit restrictions of open communication
			Design rules with regard to the maximum lapse of time to withhold publications on an invention
Internal fragmentation and conflict	Avoid growing institutional fragmentation		Establish university-wide policy for the development of university-industry linkages
			Redistribution of generated income, also to units which have a lower potential for university-industry linkages
			Favour university-wide interfaces rather than departmental structures
Conflict of interest	Protect public interest in the commercialization of products from pharmaceutical and medical research	Design a national regulatory framework with regard to the commercial interest in an invention, in particular in medical or pharmaceutical research	Design institutional guidelines for the amount of equities (minority!) a researcher is allowed to have in a commercial venture
			Design rules with regard to his/her participation in governance structures of private enterprises
			Design rules in particular forbidding trials on patients if researcher has an interest in a firm that will commercialize the product
		Design rules with obligations of disclosure	Design with obligations of disclosure of possible economic interests

PART I:
TRENDS IN THE MANAGEMENT OF UNIVERSITY-INDUSTRY LINKAGES: WHAT CHALLENGES ARE AHEAD?

by Gudmund Hernes and Michaela Martin

INTRODUCTION

Modern universities combining teaching and research, developed in the early nineteenth century, have evolved. From being largely institutions of higher education and basic research, universities since then have increasingly assumed social functions and the third pillar of the university mission to the social environment - i.e. services - has gradually emerged and been increasingly consolidated.

University-industry partnership is a relatively new phenomenon that emerged during the past century and has strongly expanded in scope and number over recent decades. University-industry linkages cover a large range of diverse realities in both teaching and research, from the more traditional, such as student placement schemes, staff exchanges, consultancy services, continuing professional development, joint R&D, to recent areas such as small enterprise development - the creation of spin-offs for the joint commercialization of R&D products and the development of consortia for collaborative R&D at the international level.

The driving forces that have transformed the scope and nature of university-industry linkages are both internal and external to higher education. They are greatly tied to a change in the perception of the mission of higher education institutions, by society in general, and by governments in particular, as well as in their own expectations with regard to the economic pay-off of university-industry linkages.

For a long time it was assumed that knowledge created by universities through basic research and education would be transformed into process and product innovation in a strictly linear, though highly unpredictable, fashion, and only on a long-term basis. Maxwell's equation, for instance, became useful much later for radio

transmissions. In the current context of knowledge-intensive economies, globalization and an ever more rapidly developing scientific and technological knowledge base, higher education institutions have been acknowledged as strategic actors in national and regional economic development. Both long and short-term contributions to economic development are now conceivable and desirable (Etzkowitz and Ledesdorff, 1997).

The assumption of changing from a linear to a more spiral model of innovation, based on networking and the change in time-frame from long-term to both short and long-term contribution to economic development, corresponds to fundamentally changing expectations from economic pay-off of knowledge. Three examples follow to illustrate this possibility.

- Gottfried Wilhelm Leibniz, a German philosopher and mathematician, laid the foundations for the binary system of numeration in the late seventeenth century. Without his work, the economic success of a Bill Gates seems to be questionable. However, Leibniz's advances in basic mathematical research had of course no direct economic pay-off, neither to him nor to his employer.

- Kristian Birkeland, professor at the University of Oslo, conducted basic research on electricity by producing large sparks, which he found to keep going as a 'spark-arch'. He then discovered that nitrogen was released from the air - which he suggested could be used for fertilizer. This became a major use for the rich sources of hydroelectric power in Norway, and the entrepreneur Sam Eyde, together with French venture capitalists, invested in the idea and founded what became the largest company in Norway, Hydro. In this example the university researcher got the fame, the entrepreneur made a mint, but the University of Oslo did not take any benefit.

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- A third example comes from the USA. A professor from the University of Wisconsin, Harry G. Steenbock, discovered in 1925 that adding vitamin D to milk could prevent rickets. The Wisconsin Alumni Research Foundation (WARF), a non-profit Wisconsin foundation, was formed to commercialize his discovery. Since that time, WARF has grown and increased its grants to the University of Wisconsin, Madison, through a constant stream of innovative technologies developed by highly creative and respected on-campus researchers. Within seven decades since the period when Professor Steenbock first presented his vitamin-D breakthrough, over 3,000 discoveries have been disclosed to WARF. Based on these disclosures, WARF has obtained over 1,000 USA patents and over 1,500 foreign equivalents and has granted an excess of US$450 million in university funds. The moral of this example from the USA is that smart people can make smart money, and more importantly smart institutions can have a considerable share in it.

Mainly driven by financial imperative and expected benefits, some developed countries have built up a long-standing tradition of collaboration between universities and industry, particularly in the USA, gaining considerable experience in the commercial exploitation of intellectual property. However, in most other OECD countries, such relations have only recently developed and intensified - during the past two decades - and universities still tend to fight with an important number of policy issues. Higher education institutions in the developing world are in fact a very heterogeneous group and they comprise the full range of top-level research to teaching-only institutions. Their level of involvement and expertise within the realm of university-industry linkages varies considerably from country to country and even from institution to institution.

Whatever their level of development, higher education institutions, both in developing and developed countries, are seeking advice on policies and structures that make ventures with industry successful and profitable for them, both in terms of knowledge creation and economic benefits. University-industry relations bear great potential, but they also produce unintended effects. Sound management procedures and structures, with a view to obtaining the best benefit in terms of knowledge creation and transmission, as well as economic pay-off, are currently acknowledged to be crucial success factors for sustainable partnerships with industry.

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I. WHAT DETERMINES THE CHANGING NATURE OF UNIVERSITY-INDUSTRY RELATIONS?

Higher education institutions are said to belong to society's more conservative organizations in that they concentrate on the same traditional core activities, knowledge creation and transmission, the latter using basically the same set of technology as was used eight centuries ago. This is especially true concerning teaching. The research function has recently undergone manifold changes, both in its nature and in its societal expectations, as well as in the way in which it is conducted. Today, top-level research in the field of science and technology tends to be no longer organized as a departmental activity, but to be based on strategic networking at the international level (Gibbons, 1998). The international project on the human genome is a widely known example from life sciences of this type of international networking.

The attitudinal changes, which have occurred both with regard to the mission of higher education institutions and the expected economic pay-off from collaborative activities, relate to three broader changes in the environment of higher education institutions: the emergence of knowledge-based economies, a changing government role, and financial stringency, combined with more targeted funding policies.

Emergence of knowledge-based economies

Factors having a great impact on both universities and industries include:

- globalization and increased economic competition, at the international level;

- the triumph of capitalism and the supremacy of market-based approaches;
- technological change – an increased demand for lifelong learning;
- tremendous change in social expectations for education worldwide as a preparation for life.

These broader societal changes coincide with an explosion of the volume of scientific knowledge, which is also linked with a trend of atomization of knowledge production, in particular within developed countries. Universities in many countries have lost the monopoly on scientific knowledge creation and dissemination, simply because they were able to train ever-growing numbers of graduates, thus developing scientific capacity outside higher education, among private firms. Although having lost this monopoly, they have gained greater opportunity for partnership with enterprises whose workforce, especially in R&D departments, has also become an adequate partner for interaction in the R&D domain. Current R&D often requires an increased breadth of knowledge for scientific discoveries, as well as more calls for new combinations of available knowledge and, again, the development of networks beyond institutional boundaries.

More recently, under the influence of international economic competition, enterprises increasingly tend to 'outsource' non-core function, i.e. applied research and professional development of their staff. They have been shrinking in size and within 'lean and mean' management practices, have become more selective about their partner organization. Building up 'strategic alliances' in order to improve one's market position has become the rationale for partnerships at a time when knowledge means money and money means access to knowledge. Enterprises are increasingly appreciating

the high-technology science base of industry, such as biotechnology, pharmacy and microelectronics, which is often complementary to the research performed in industry. Universities themselves are often obliged to collaborate with multinationals in specific applied areas where industrial R&D is ahead of university research, e.g. microelectronics (Blackman and Segal, 1993).

In many developing countries R&D intensity tends to be relatively weak and the shares of researchers in the labour force low. The public spending on R&D tends to be the most important source of funding, since private funding of R&D is insignificant, given the fact that most of the enterprises belong to low and medium-technology industries. Finally, these countries, and in particular their enterprises, the majority of which belong to the SME sector, often depend on imported technology. Globalization of science and R&D, however, and growing international networking of firms, will also quickly enhance the potential of collaboration, in the R&D domain, between universities and multinational enterprises in developing countries.

The 'triple helix model' of government-university-industry interaction

A relatively new phenomenon in the domain of university-industry linkages is the changing role of governments in the stimulation of university-industry ties for, in knowledge-intensive economies, innovation is a major driving force for local and national economic development and job creation. It is also believed that innovation increasingly relies on effective interaction between the science base and the business sector and that networking and collaboration at local, national and international levels among diverse actors are necessary to build up capabilities (OECD, 1999).

Over the past decades, governments have increasingly developed policies which aim at securing framework conditions conducive to

innovation (such as macroeconomic policies, appropriate legislative frameworks and targeted science and technology policies). These policies remove specific barriers for innovation and increase synergies between public and private investment in innovation. In particular, they have established new types of incentive and support structures that concern both higher education institutions and enterprises, often simultaneously. Incentive measures range from:

(i) fiscal alleviation for R&D expenditure by enterprises, in particular if it is channelled through universities;

(ii) targeted programmes providing matching funds for university-industry relations in selected scientific fields;

(iii) development of an administrative framework for universities capable of using extra-budgetary funds flexibly;

(iv) technology-transfer structures such as agencies or incubators and/or provision of seed money for the commercialization of R&D products through university spin-offs.

The *Bayh-Dole Act* adopted by the American Congress in 1980 is an important example of governmental intervention to provide a favourable framework for university-industry linkages, in particular concerning the commercialization of research results. The Act transferred the rights to intellectual property generated under federal grants from funding agencies to universities, thus providing them with the opportunity to exploit research results commercially. Another, perhaps more targeted, strategy is the setting up of centres of excellence or co-operative university-industry research centres within universities. This new mode of tripartite interwoven interaction has been called, more recently, the 'triple helix model' of university-industry-government partnership (Etzkowitz and Ledesdorff, 1997).

Decline in public core funding and growing entrepreneurship in universities

Governmental core funding to higher education institutions has been declining. This is particularly so in developing countries, whereas in developed countries the total amount is often stagnating or on the increase. After careful analysis of funding trends, from 1980 to 1995, it can be noticed that in most developed countries the share of the education budget, in overall public budgets, has been declining, whereas the share of higher education in the total education budget has been growing, leading more or less to stagnating total budgets, in general (Varghese, 2000). However, since student numbers were growing over this period, real expenditure per student actually decreased. In developing countries, overall education budgets have grown but, according to many cases, resources have shifted from higher to basic education. In addition, donor funding tends to be allocated to basic education, to the detriment of higher education. The world average of per-student/GNP per capita funding (percentage) has declined from 163 per cent in 1980 to 77 per cent in 1995. In high-income countries, such as most OECD countries, this percentage declined in the same period from 39 to 26 per cent, and in low and medium-income countries, from 259 to 91 per cent.

In many instances, the decline of public funding for higher education was expected to be compensated for by private contributions, such as student fees and direct payment by enterprises for specific services, meaning a shift of burden to the users of higher education outputs. It should be noted that, in most OECD countries, the R&D's share in higher education, funded by private enterprises, has increased without, however, becoming a dominant source of funding (see *Table 2*). Indeed, in OECD countries, industry tends to account for a small share of university funding, not more than an average of 5 per cent (OECD, 1998).

Table 2 – Share of R&D in higher education funded by enterprises in selected OECD countries

Country	1980	1990	1995
USA	2.5	4.7	5.8
Canada	3.9	6.3	10
Japan	1.0	2.3	2.4
Australia	1.4	2.1	3.5
France	1.3	4.9	3.2
Germany	2.0	7.8	7.5
Sweden	2.3	5.2	6.2
UK	2.8	7.6	6.2

Source: OECD, 1998.

Under the influence of stagnating or declining budgets, many higher education institutions have become more entrepreneurial. A recent study by B. R. Clark (1998), of five Western European entrepreneurial higher education institutions, has shown that, within a context of governmental cutbacks, they were increasingly capable of supplementing declining public funds through entrepreneurial action, university-industry linkages taking a major part in it. Following an analysis of the growth rate of different sources of funding (public and private) for these five entrepreneurial universities, Varghese concludes that growth rate for private funding in these universities experienced a major boost from 1975 till 1990 (starting at a very low level). However, it tended to decline once it had reached a certain level (Varghese, 2000).

From the above-mentioned trends of declining core funding and growing governmental intervention for the stimulation of university-industry linkages, one may conclude that governments have become more *or* less involved: less in their general funding to universities

and more with regard to providing incentive for specific initiatives. Both financial stringency with regard to governmental core funding and the creation of incentive, shifting money from traditional activities to the development of university-industry linkages, have become effective driving forces towards the development of worldwide university-industry linkages.

II. WHAT ARE THE TRENDS IN THE MANAGEMENT OF UNIVERSITY-INDUSTRY RELATIONS?

The current pressure for universities to establish closer and more varied university-industry relations has modified in intensity, scope and nature, on a worldwide basis. Many aspects related to university-industry linkages have been studied intensively and documented thoroughly, e.g. the impact of science and technology policies on university-industry linkages, the changing nature of such linkages, funding issues and organizational models for the development of university-industry linkages. However, one tends to neglect the implementation aspect of linkages, their management within universities and enterprises, despite the fact that it is perceived to be crucial for a profitable and sustainable partnership in the long term.

Since 1990, the IIEP has been conducting case-study research on the institutional response to financial stringency in both developing and developed countries through organizational change and innovation in resource management (Sanyal, 1995). Given the growing importance of university-industry linkages, it was decided to launch a specific project concerned with identifying innovative strategies in the management of university-industry linkages, mainly in developing countries, through case-study research. Managers of university-industry linkages (such as pro-vice-chancellors, interface managers, heads of department) from 12 European, Latin American, Asian and African institutions, were invited to document their innovation in this area, with respect to the following four major research questions.

1. Are processes in the realm of university-industry linkages based on institutional policies or strategic management?

2. What organizational development has been established in order to support these institutional policies, i.e. top-down or emergent?

3. What changes have been introduced to the management of crucial resources, i.e. finance and staff?

4. Are there existent policies for intellectual property rights?

The following 12 institutions from various development contexts (a Western industrialized country, middle-income countries, countries in transition and least-developed countries) participated in this research conducted from 1997 to 1999:

- *Africa:* Makerere University, Uganda;

- *Arab Emirate States:* University of Cairo, Egypt, *École Supérieure de Technologie de* Casablanca, Morocco;

- *Asia and the Pacific:* Suranaree University of Technology, Thailand; Technological University of Papua New Guinea; Birla Institute of Technology and Science, India;

- *Europe:* Technical University of Lodz, Poland; Hebrew University of Jerusalem, Israel; Bogaziçi University, Turkey;

- *Latin America and the Caribbean:* UNAM, Mexico; University of São Paulo, Brazil; University of the West Indies.

A summary of the findings, documenting the synthesis report published by the IIEP in 2000 *'Managing university-industry*

relations: institutional experiences from 12 case studies', is at the end of this paper (*Table 3*).

Scope of university-industry linkages

The case studies on the management of relations with industry confirmed the considerable development and institutionalization of these relations over the past decade. This phenomenon is present in all analyzed universities, thus within all development contexts. If such relations have developed in number, it is also fair to say that their scope has widened to embrace new types of linkages and modalities for their implementation. Therefore, traditional types of linkages tend to coexist with ones that are more recent.

Concerning traditional types of linkages, placement schemes for student internships are still a predominant mechanism. Innovative ways of organizing student placements have been presented in the case studies, for example:

- the practice school scheme at the Birla Institute of Technology and Science (BITS), in India – a relatively small private university with specialization in engineering and computer science;

- the co-operative education programme at Suranaree University of Technology (SUT) in Thailand – a newly established, provincial technological university.

Recent types of linkages developed include those in the field of continuous professional development and consultancies, especially within universities of developing countries. It is within a context of resource constraints that such activities are more easily marketable and universities tend to marketize products that have a comparative advantage over other providers.

A further recent and increasingly important type of linkage is in enterprise development. Many higher education institutions, and nearly all case institutions, have set up special structures, e.g. incubators or innovation centres, or specific programmes of enterprise development, e.g. the Uganda Gatsby Trust, at the Faculty of Technology of Makerere University. Enterprise development may be geared either to the strengthening of existing SMEs, or to the creation of start-up firms, usually set up by an academic staff member or a graduate student to commercialize a university's invention. So-called business incubators or innovation centres usually logistically support start-up firms, through an interface structure managed by the university, in which it plays an important role. Given a more active part in the area of enterprise development, the university becomes an increasingly important partner in local economic development. One might conclude that there is, in general, a tendency for linkages to be planned and developed as strategic alliances, rather than as part of simple collaborative work conducted in the short term.

With regard to types of linkages, it can be concluded that in Western industrialized countries many university-industry partnerships tend to focus on contractual R&D and technology transfer, whereby licensing and spin-off creation have become rather common features. Since research capacities are much weaker in many developing countries, consultancies and continuous professional development are the most prevalent types of partnership found. Small-enterprise development has also gained a better place on the agenda, but such schemes often need outside support provision (such as donor funding), since universities do not always have the means to invest with their own resources in such non-traditional, and not necessarily profitable, activities.

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Strategic management of university-industry linkages

According to the different institutions examined, relations with the private sector, as in most other universities, are not a new phenomenon. Nevertheless, they have been, and often still are, the result of particularly dynamic staff who have specific professional interest in them. Consequently, most university-industry linkages, e.g. the Policy Forum case studies, have developed in a 'bottom-up' manner. It is now acknowledged that one of the crucial success factors in the management of university-industry linkages is the establishment of an institutional strategy for the development of such relations, for instance in a strategic document, development plan or any other written statement of policy. Some of the case institutions have adopted a documented, centralized and structured approach:

- the Hebrew University of Jerusalem, a major Israeli research university with about 20,000 students;
- the University of São Paulo, a leading Brazilian university in research, with a post-graduation of 60,000 students;
- the National Autonomous University of Mexico, a mega-university and the major research pole among the Mexican universities;
- Bogaziçi University, an English-speaking, elitist Turkish university.

The Rector of the University of São Paulo, for instance, has testified, in an internal planning document, that the development of university-industry relations is a policy priority. Bogaziçi University mentions the existence of a strategic plan. In 1996, a subcommittee on technology transfer prepared guidelines for a more focused orientation of activities, such as "choose high-tech issues for consultancy rather than routine tests for standard practices of

projects". Strategic management of university-industry relations certainly implies not only the formalization of policy priorities, but also top-level management support which is particularly necessary in giving selective assistance and back-up to initiatives emanating from academic departments.

However, despite top-level policy support, strategic management of university-industry relations has not proved to be a well-established practice in all of the sample institutions. Relations with the socio-economic environment, in the other cases, still seem to depend on the particular dynamism of specific individuals - often teaching personnel - with experience and personal contacts within industry. As a rule, academics are the most important actors in university-industry linkages. They do not usually appreciate being constrained by university-wide rules and regulations, and do not formalize institutional policy in an institutional planning document. Measures to foster university-industry linkages are generally concerned with creating an enabling environment and setting up supportive structures, such as internal or external interfaces.

Development of interface structures

All of the case studies have demonstrated that the creation of interfaces, be they internal or external, is a common feature for developing university-industry relations. The discussion mentioned above, see (2), shows a number of trends, the first being ***an increasing diversification and specialization of interfaces.*** This is not surprising, given the fact that the objectives of these relations have become more diverse. If the initial objective was to foster knowledge transfer from higher education institutions to industry, the income-generation purpose now has higher priority and drives relations with industry forward in forms that are more diverse. The case studies also show

that relations with industry reflect a dynamic process in the diversification of organizational structures, at the institutional level. If institutions often commence by setting up an industrial liaison office, they then, throughout time, establish external interfaces, such as foundations or consultancy centres. The manifold tasks implied by managing university-industry relations require professional management with many specialized competences, hence more complex structures.

The *national legal framework* for interface development also plays an important role. For instance, in many countries commercial interfaces are incompatible with national public laws. Yet, in other countries, national governments make seed funding available for setting up interface structures.

Specialization of interface functions is taking place in a context where such support structures receive *increasing autonomy*, bypassing internal rigidities such as administrative rules and existing organizational structures along departmental lines. Administratively autonomous interfaces are thus able to:

- contract personnel with specific required skills, particularly within the technology management area;
- purchase necessary equipment and materials;
- organize interdisciplinary teams;
- negotiate contractual arrangements, etc.

The particular challenge, however, for the mother institution is to control these structures, ensuring that they all contribute to overall institutional mission and policy. Most universities have developed effective mechanisms, both formal and informal. Formal mechanisms are rules and regulations that stipulate the level of autonomy for

interfaces, whereas informal mechanisms strive to place high-level university managers on their governing boards, sometimes even at the top executive level of interfaces. Top managers of such interfaces tend above all to be professional managers, most often possessing some experience from academia, which enables them to direct the interface in a professional manner.

Interfaces discussed in the case studies distinguish themselves very much by their level of centralization. This issue is strongly linked to the question of controlling and securing communication through the basic units of the alma mater. Only four of the case institutions have university-wide interfaces:

- YISSUM of the Hebrew University;
- BUVAK of Bogaziçi University;
- UDC of the Papua New Guinea University of Technology (a relatively small university located in the capital of PNG with technological specialization);
- Technology Innovation Centre of Birla Institute of Technology and Science.

Faculties or departments set up all other interfaces:

- the University of São Paulo foundations;
- the Institute of Continuing Education of the Faculty of Engineering of the University of the West Indies;
- TECO of the Faculty of Technology at Makerere University, the main comprehensive university in Uganda, a least-developed country in Southern Africa.

As far as their internal structuring is concerned, several of the interfaces reproduce the departmental structure of their mother institution or faculty. This again illustrates that interfaces are set up in such a way that basic units (i.e. departments) may have direct control over their subsidiaries. This type of organizational structure ensures direct communication between the basic unit and its subsidiary and it strengthens the departments' ownership. Decentralization and organization of interface units, however, along the lines of alma mater does not allow for establishing university-wide policies for university-industry linkages and overcoming obstacles to interdisciplinarity.

Financial management issues

Beyond the issues of strategic management and organizational development in university-industry relations, the case studies also explored innovative methods in the operational management of such relations. As far as financial management is concerned, income-generation impact can be considerable. At the University of Bogaziçi, income-generation activities of a diverse nature represent about 14 per cent of the total university budget and exceed contributions coming from tuition fees. Consequently, Bogaziçi is one of the universities that have succeeded in establishing a diversified income basket and in creating an authentic margin of autonomy.

Within this context, higher education institutions are currently designing appropriate instruments for costing and pricing products and rules for determining appropriate overhead provision, as well as the distribution of generated income. They are also developing instruments such as risk capital to finance high-risk joint ventures with enterprises. With regard to costing and pricing, the universities studied mention that their price setting is usually guided by a ***full cost approach***, and not by a price that the market will bear. Institutions

generally charge a *flat overhead rate* for the use of equipment and central services, which depends more commonly on a political decision, rather than on detailed analysis of cost structures. They are struggling, nonetheless, with identifying the precise full cost of a product or service, especially in the R&D domain, given the fact that traditional accounting systems do not distinguish services related to teaching from those related to research. Some universities, however, differentiate overhead rates depending on whether or not the work is laboratory-based, the former entailing a higher overhead rate.

With regard to the issue of distribution of income, generated from collaboration with the productive sector, through a pre-determined overhead from licensing arrangements, the case studies have brought to light that institutions adopt very different practices. This reflects divergent, underlying conceptions of the place of work with industry. Those who consider such activities as part of the mainstream mission, foresee a rather small percentage of the generated income for the individual who has performed the job. Most institutions, however, assume that work with industry is not one of their mainstream activities, believing that individuals should receive a specific remuneration for such work. As part of a licensing agreement, the inventor receives generally up to 50 per cent of the income, and 20 to 40 per cent of the overhead. Preference is given to distributing generated income that acts as a financial incentive to individuals or teams of researchers. Again, some institutions distinguish by their rules whether or not work is laboratory-based. In the case of joint laboratory-based R&D, a greater share of generated income goes to the institution or to the department, in the case of a devolved budgeting system. None of these options is preferable. What is important is that the academic community accepts and recognizes the rules.

Staff management issues

Questions posed by the research were about current staffing issues, staff development initiatives and motivation systems. The question of staffing and staff development is, of course, paramount, since the strengthening of relations with industry depends mainly on the competency and skills of staff involved, as well as on the building of understanding and awareness among all personnel, both academic and support staff. No university studied, and very few universities worldwide, conduct audits in order to determine precise required competences and to offer appropriate training schemes. With a view to developing relations with industry, staff recruitment and development are rarely based on a 'need' analysis, but are more generally performed in an ad hoc manner, if at all. The Practice School scheme at BITS is an interesting innovation, which regularly places teaching staff in enterprises, allowing them to both collaborate in projects and supervise students ***in situ*** during their internships. The Centre for Technological Innovation of UNAM in Mexico is used to offering, to university staff, in-house training on specific topics related to technology transfer, as part of a strategy of awareness-creation of the need for technology transfer and cultural exchange. The University of São Paulo has a similar training provision. These institutions are, however, quite large with a well-developed R&D capacity.

The more common strategy used by the other institutions studied is that of recruiting new staff. This may be for the liaison office, for instance, with the appropriate competences: working experience in industry and a good knowledge of R&D work in university. Competences that are more specialized, such as those related to the management of intellectual property, as well as knowledge, are often subcontracted by universities. This is not, however, always without problems, since outside specialists often do not understand the

nature of university-based R&D work, thus leading to internal conflict and delay in negotiating the terms of reference for contract work.

Within the framework of university-industry partnerships, universities are also increasingly confronted with a more diverse staff profile, due especially to young staff increasingly hired on a contractual base for a fixed term. This situation often creates internal conflict, because this staff does not enjoy the same favourable employment conditions as tenured staff, e.g. access to staff development. It will become increasingly necessary for universities to give special attention to this issue in order to maintain young and promising staff within the university sector.

However, appropriate staffing and staff development are not sufficient for motivating university personnel to engage in university-industry relations. What is really at stake is creating a change in culture and atmosphere, from the collegial to the entrepreneurial type of institution. Financial or material incentives are necessary to signal to staff that the institution values their involvement with the private sector. All case institutions have put into place a series of incentives, some of which recognize collaborative work in decisions on promotions. If national personnel statutes render changing promotion criteria difficult, institutions try to provide material incentives, such as refurbished office space, or access to travel grants, to motivate staff. In one case institution, the Hebrew University of Jerusalem, a direct supplement to the basic salary has been determined to remunerate staff for their efforts in collaborative projects.

Management of intellectual property rights

A last issue addressed in the case study research was the management of intellectual property. Universities have very different policies with regard to who benefits from intellectual property

grants. The Hebrew University of Jerusalem, for instance, has gathered considerable expertise in this domain, reserving for itself the right to first disclosure of potential R&D commercialization and exploiting intellectual property gained from patent. The case universities from developing countries acknowledge the potential importance of this issue, but many have not yet acted. They lack well-developed practices and Intellectual Property Rights (IPRs) go mostly to the inventor, who is then also in charge of claiming the filing of a patent. Their relatively low involvement in this area is partially due to the fact that joint R&D between the university and the productive sector is less developed than in most OECD countries. We may mention other factors, such as a weak legal framework and no tradition for protecting the R&D patent. Finally, it is often difficult for universities in developing countries to bring an invention up to a stage where they may request a patent. This often requires considerable supplementary investment and expertise and available public or private capital, which is difficult to raise in the absence of venture capitalists. It is only when universities expect important benefit from the commercialization of IPR – through royalties, licences or equities in spin-offs – that they set up appropriate policies, structures and procedures in this domain.

Through its subsidiary – YISSUM – the Hebrew University collects considerable income from IPR. YISSUM has reserved itself exclusive rights in this domain, centrally managing all issues, including the following: (i) negotiation of IPR terms with industrial partners; (ii) setting up of joint ventures for financing further development towards bringing inventions to a patentable stage; and (iii) filing of patents and their commercialization through licensing. However, most other case institutions involved in collaborative R&D either leave IPR to individual staff responsible for the R&D project, share IPR with a collaborating industry, or leave it entirely to the industrial

partner. If inflexible rules regarding intellectual property rights prove to be an obstacle in negotiating terms for joint R&D, neglecting issues of IPR prevents universities from capitalizing on their inventions institutionally.

III. WHAT CHALLENGES LIE AHEAD IN THE MANAGEMENT OF UNIVERSITY-INDUSTRY LINKAGES?

The case studies have demonstrated that higher education institutions, within different development contexts, may be very innovative with respect to policy formulation, organizational development and procedures in essential areas of managing university-industry linkages. However, they have also brought to light a number of issues with which universities are currently struggling. Within the context of present economic imperatives and impressive opportunities for individual and collective scientific entrepreneurship, university-industry linkages may provoke a number of unintended effects. Some effects are the following:

- possible distortion of research and training agendas;
- diversion of energy;
- commitment of individual staff interacting with industry;
- limitation to open communication and publication;
- internal fragmentation and conflicts among different groups within higher education institutions.

In order to avoid the above-mentioned negative impacts of university-industry linkages, both governments and higher education institutions have a role to play. They should strive to identify such unintended effects, as well as their inherent danger, thus defining policies and establishing rules and regulations to protect intrinsic values and interests of higher education institutions. Following is an

outline of a series of questions drawn on the experience gathered from the case studies, to show how universities manage these current challenges in university-industry linkages. Occasionally, experiences from the USA will supplement those taken from the case studies because the American institutions already address challenges that higher education institutions in other parts of the world will more than likely face.

Which university-industry linkages are compatible with the public service function of the university?

The account of developing and diversifying types of linkages with industry poses the question of whether, and to what extent, such activities are actually or should be part of the public service function of traditional universities. If technology transfer has a fundamental role to play in local and national economic development, should enterprise development and licensing still be the business of higher education institutions?

With regard to collaborative R&D, long-term basic research activities are in several case institutions complemented by short-term, goal-oriented strategic research activities, where expected outputs are already specified from the outset. What happens if such short-term operations reach a certain density, or if they become the major source of funding for a laboratory? A possible answer to this question might be in developing a strategy whereby institutions aim for a mixed basket of research activities with funding from different sources, both public and private. National policies for scientific research have a particular role to play in enabling institutions to strike this desirable balance.

Moreover, opportunities for income generation, at the level of the individual researcher, may become a considerable hurdle for

'disinterested' research. It is in medical and pharmaceutical research, in particular, that expected economic pay-off, for new drugs or medical devices, may be substantial. In countries such as the USA and Israel, where there is strong capacity for medical research and researchers participate in the commercialization of their research, conflicts of interest may be generated. When researchers, in particular, are involved in trials of products which are commercialized by a firm in which they have equities, or for whom they are members of the scientific advisory boards, their scientific independence may no longer be assured. Policy-makers must address another issue, both at national and institutional levels. The Hebrew University, for instance, obliges its researchers to disclose any interest they have in an enterprise, and rules have been established, by the university, with regard to the maximum amount of shares a researcher may hold in such a commercial venture (not more than 10 per cent).

In the USA, the commercialization of research results is highly developed, frequently creating conflicting interests. Since 1980, higher education institutions are encouraged by law to patent innovations, assigning this right to private enterprises that commercialize products of often publicly funded research. There is at present no federal regulation that governs relationships between scientists and the companies they create. Universities are required to establish their own rules, which tend to vary considerably from one institution to another. Many universities, among them the best-known research universities, have indeed set up rules that discourage the creation of spin-off companies, since they fear that potential conflicts will be unmanageable. They do encourage and facilitate licensing arrangements, many of which yield considerable income. This does not prevent, however, academic entrepreneurship and many academics are known for setting up their own firms without any support from their alma mater.

Most institutions from the developing countries studied here have become more active in the domains of consultancies and continuous professional development. These universities have to ask themselves whether such activities provide them with additional value in terms of knowledge creation, and if they have comparative advantage over other organizations and institutions in this domain. Again, several universities in the USA have established policy guidelines which stipulate that preference needs to be given to collaborative activities which have potential for generating knowledge and enriching the professional experience of students and staff.

How to maintain a culture and practice of open communication?

The case studies deplore cultural differences between universities and industry, caused by pursuing different objectives and having to face different time constraints, and consider these differences to be an obstacle towards the development of university-industry relations. There are indeed different time horizons for research outputs: short and definitive in the case of industry; long, indefinite and flexible in the case of academic staff. Industry strives to benefit from practical exploitation of results and optimum testing, whereas university staff search for knowledge, new theories and thoroughness. The private sector generally prefers confidentiality in terms of research results, whereas university staff seek to publish. It is essential, for academics, to publish their research results, for both career advancement and development of professional recognition and network. If a collaborative project has created knowledge having direct or indirect commercial value and leading to commercial exploitation, through a patent or licence, it is in the interest of industry, and sometimes even of the individual researcher, to postpone publication as much as possible, or at least until the research is evaluated and any patent application filed. Since

confidentiality is a contentious issue in negotiating an R&D contract, it is generally the part of the bargaining process that leads to establishing the terms of reference for a collaborative project. Companies generally offer assurance that an agreement to publish will not normally be withheld, up to an agreed time horizon specified by the terms of reference of a collaborative project. The Hebrew University of Jerusalem has become watchful with regard to those limitations and has established guidelines with regard to the maximum time-span that may constrain a researcher to withhold publication (usually not more than six months).

Beyond constraints on publication, industry-sponsored research can also entail, in general, an obligation to secrecy within the academic community of a higher education institution. If this obligation to secrecy is imposed on a particular research team, it may considerably constrain fruitful communication among colleagues within the department, or even, though less frequently, between departments. On the other hand, simply if part of the staff in a department benefits from a major private research contract, universities should be opposed to restriction on the flow of information. Many universities, in particular in the USA, have developed rules preventing institutions from engaging in joint R&D with obligations to secrecy.

How to avoid conflicts of loyalty-commitment, such as diversion of energy and funds?

The case studies have confirmed that collaborative activities with industry may be highly attractive to staff, who see them as an opportunity for enhancing research, upgrading their knowledge base, and generating supplementary income for their department and themselves. There is still, and always has been, an inherent danger that traditional duties, in particular teaching activities, might suffer.

The case studies showed that traditional rules are very different from one country to the other and are very dependent on prevailing 'personnel statutes', designed either at the institutional or national levels.

In Poland, for instance, before the change in regime, it was simply forbidden for university staff to conduct any outside activity. In most Latin American countries, such as Mexico and Brazil, academic staff have specific employment conditions which indicate their tasks and the length of time they are to spend at the university. Such employment conditions provide a frame of reference for time that is then to be dedicated to private work. As far as the other case institutions are concerned, however, a certain amount of time which is allocated to private activities – such as consultancies – is not only tolerated, but considered to be desirable in domains such as law, medicine and engineering, provided that academics meet other academic commitments satisfactorily.

Some universities, such as the University of São Paulo and the Hebrew University, have established rules concerning private long-term consultances needing official approval by the head of institution. The *20 per cent formula* is applied in these institutions, and within most institutions worldwide. According to this formula, a staff member is allowed, under certain circumstances and with the permission of the head of institution, to take one day of leave per week for private consultancy, under the condition that the work is not done during term-time and that it should complement the research interest of the academic and of his department.

It should however be emphasized that the existence of rules is only one aspect of the issue. It is necessary, but often insufficient. The other aspect is to find mechanisms that allow an institution to ensure that staff adhere to the rules. Most institutions in developing

countries face major difficulties with staff neglecting their university duties, which is a situation that is connected to very low salaries that often oblige staff to 'moonlight'. Supervision of staff and control of the compliance with their workload can only be done at the departmental level. However, heads of department in many countries do not play a leadership or supervisory role and are equipped neither for sanctioning nor for rewarding their immediate academic colleagues. Consequently, the existence of rules and procedures for outside work needs to be accompanied with management changes giving supervisory staff power to play their role with regard to other academic colleagues.

How to avoid increasing institutional fragmentation and growing internal conflicts?

The case studies have brought to light the fact that opportunities for collaboration with industry, in particular in the R&D domain, are unevenly distributed within institutions. By nature, they exist mainly within the different engineering domains - computer science, biotechnology, pharmacy and medicine. Other scientific fields, such as business administration and languages, have greater potential in continuous professional development and in consultancy activities.

The natural trend in all higher education institutions is one of centrifugal force, meaning that researchers and teachers naturally identify more easily with their professional or disciplinary community, rather than with their institution. University-industry linkages provide a supplementary force that drives researchers and teachers out of their institutions. This reinforces the common trend of institutional fragmentation and often creates internal conflicts between faculty and academics, as well as between different departments. As a consequence, in a typical higher education

institution, some scholars are naturally inclined to favour developing linkages with the private sector, usually for professional reasons, in absence of any institutional policy, whereas other academics are by nature and discipline much more hesitant. It is a difficult task to balance the diverse professional institutional interests of scholars and to reach the necessary consensus on objectives and desirable action. One may hypothesize that this is probably one of the reasons why strategic management of university-industry linkages is a relatively rare phenomenon to have been observed within the case institutions.

A strategy which may simplify consensus, is formulating rules pertaining to the distribution of generated income. The case studies have demonstrated that institutions tend to design formulae for distributing income generated from surpluses or patents/royalties among the institution, department and individual. If part of the money that is generated by some basic units, and levied off by the institution, is redistributed to entities having a lower potential to generate such funds, this internal fragmentation may be counteracted. All entities of a university may also benefit from the resources generated from collaborative activities with industry. In order to maintain their tax-exempt status, universities do generally adopt guidelines whereby part of the overhead provision or income obtained from licensing agreements goes to an institutional research fund and can be used for financing future research activities. Such rules, in particular if they do not allocate funds directly to the entity that generated them, often induce, once more, internal conflicts, given the highly political nature of internal resource allocation within a university.

Table 3 – Summary table on existing policies, structures and processes at case universities

University	Interface developed	System for financial management	System for staff management	Policies for IPR
BITS	Technology Innovation Centre	Pricing policies Distribution of income	Practice school periods for staff Promotion criteria	No
Bogaziçi	BUVAK Foundation + three subsidiaries	Pricing policies Distribution of income Flat overhead rate	Material incentives	No
HUJ	Wholly owned subsidiary Innovation Centre Science Park	Financial incentives Pricing policy Distribution of income Flat overhead rate	Promotion criteria Rules for outside activities Rules for conflict of interest	Yes, university is owner of IPR
Makerere	Consultancy Centre TECO	Pricing policy Distribution of income	Material incentives	No
PNGUT	Commercial arm UDC	Pricing policy Distribution of income Flat overhead rate	Material incentives	No
São Paulo	Internal interface CECAE 24 Foundations	Distribution of income	Staff development programme Promotion criteria Material incentives Rules for outside activities	Yes, accepts shared ownership
SUT	Innovation Centre Science Park	Distribution of income	Promotion criteria	No
UNAM	CIT (academic centre and support division for technology transfer)	Distribution of income	Promotion criteria Material incentives	Yes, university is owner of IPR

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Conclusion

In conclusion, the boost in university-industry linkages may be due, in many countries, to a changing socio-economic climate and favourable governmental attitudes and incentive. This changing environment poses challenges to universities worldwide for a revised policy in the domain of university-industry linkages.

One of the most important challenges for institutional policy-makers is defining a legal framework and incentive systems which stimulate entrepreneurship at the institutional, departmental or individual levels, while designing rules and regulations through which the potentially perverse effects, such as the above-mentioned, can be avoided. A balance obviously depends on particular university culture and tradition, as well as on existing outside opportunities for collaboration. However, the need to maintain an institutional identity will have to be widely considered for policy-making in the domain of university-industry partnerships.

The universities studied show that they respond to these challenges in various ways, through the setting up of new structures and processes of a different nature. It appears that many are still in the stage of local experimentation, whereas others have already adopted policies that are considered the best practice.

Such a code of best practice has much to do with the prevailing understanding of the 'university' concept, particularly in a context of diversifying higher education systems and wider competition. Institutions wishing to be considered as universities will have to show concern for maintaining some commonality of tradition and cultural values. Otherwise, what they win in the market will be lost in academia.

One can expect that, as time goes by, learning will increasingly take place *via* institutions *and* countries, hence an international code of best practice will emerge. The objective of this IIEP project on the management of university-industry partnerships is to contribute to this process.

Bibliography

Unpublished case material

Imbert, C.A.C.; Kochhar, G.S. The management of university-industry relations at the University of the West Indies. Unpublished case material.

Kaynak, O. The management of university-industry relations at Bogaziçi University, Turkey. Unpublished case material.

El Masslout, A. Relations industrie-université à l'Ecole Supérieure de Technologie de Casablanca au Maroc. Unpublished case material.

Plonski, G.A. University-industry relations. The case of Universidade de São Paulo, Brazil. Unpublished case material.

El Raghy, S. The management of university-industry relations at the Faculty of Engineering, University of Cairo, Egypt. Unpublished case material.

Satter, M.A.; Pumwa, J. The management of university-industry relations at the Technological University of Papua New Guinea. Unpublished case material.

Srisa-an, W.; Umaly, R.; Pinyonatthagarn, D. The management of university-industry relations at Suranaree University of Technology, Thailand. Unpublished case material.

Tibarimbasa, A. The management of university-industry relations at the Faculty of Technology, Makerere University, Uganda. Unpublished case material.

Turowski, J. The management of university-industry relations at the Technical University of Lodz, Poland. Unpublished case material.

Venkateswaran, S. The management of university-industry relations at the Birla Institute of Science and Technology, India. Unpublished case material.

Vigdor, M. The management of university-industry relations at the Hebrew University of Jerusalem, Israel. Unpublished case material.

Published articles and books

Blackman, C.; Segal, N. 1993. "Industry and higher education". In: G. Neave; B. Clark. *Encyclopaedia of Higher Education*. London, New York, Philadelphia: Pergamon Press.

Clark, B.R. 1998. *Creating entrepreneurial universities: organizational pathways of transformation*. Oxford: Pergamon Press.

Esteva Maraboto, J. 1997. "Managing university-industry relations: the case of the Centre for technological innovation at UNAM". *IIEP research and studies programme. Improving the managerial effectiveness of higher education institutions*. Paris: UNESCO/ International Institute for Educational Planning.

Etzkowitz, H.; Ledesdorff, L. 1997. *Universities and the global knowledge economy. A triple helix of university-industry government relations*. London and Washington: Pinter.

Gibbons, M. 1998. *Higher education in the 21st century*. Washington: The World Bank.

Martin, M. 2000. "Managing university-industry relations. A study of institutional practices from twelve different countries". *IIEP research and studies programme. Improving the managerial effectiveness of higher education institutions*. Paris: UNESCO/ International Institute for Educational Planning.

OECD. 1998. "Commercialization of government-funded research". *Background Report*. Working Group on Innovation and Technology Policy. For official use. Paris: OECD.

OECD. 1999. *Managing national innovation systems*. Paris: OECD.

Sanyal, B.C. 1995. *Innovations in university management*. Paris: UNESCO/International Institute for Educational Planning.

UNESCO. 1998. *World Science Report 1998*. Paris: UNESCO Publishing.

Varghese, N.V. 2000. "The limits of diversification of sources of funding in higher education". Paper prepared for the IMHE General Conference on *Beyond the Entrepreneurial University? Global Challenges and Institutional Responses*. 11 to 13 September 2000.

Williams, G. 1990. *Changing patterns of finance in higher education*. Buckingham: The Society for Research into Higher Education and Open University Press.

PART II:
IN WHAT WAY DO CHANGING UNIVERSITY-INDUSTRY RELATIONS AFFECT ACADEMIC ACTIVITIES WITHIN HIGHER EDUCATION INSTITUTIONS?

by Guilherme Ary Plonski

INTRODUCTION

There has been substantial expansion in higher education systems over recent decades, making them "indisputably the new frontier of educational development in a growing number of countries".[1] This enlargement has occurred mostly within low and middle-income countries.[2]

While sometimes used as a synonym of higher education institutions, universities are only a fraction of the gamut of public and private entities involved in this activity. Indeed, as posed by the Task Force on Higher Education in Developing Countries (HEDC), convened by the World Bank (WB) and the United Nations Educational, Scientific and Cultural Organization (UNESCO): "Not only have higher education systems expanded worldwide, the nature of the institutions within these systems has also been shifting, through a process of differentiation".[3] Differentiation occurs both vertically, as a reaction to the need for greater diversity of graduates, and horizontally, by the creation of new institutions.

This paper therefore begins by providing some major classifications of the spectrum of higher education institutions, enabling more focused answers to the question posed in the title.

The International Standard Classification of Education (ISCED) uses the expression "*education at the tertiary level*" for any institution that requires, as a minimum condition of admission, the successful

1. World Bank. 2000. *Higher education in developing countries: peril and promise*. (The Task Force on Higher Education and Society No. 27). Washington D.C.: World Bank.
2. According to UNESCO statistics on the tertiary enrolment data, low and middle-income countries accounted for 64 per cent of the world increase of almost 40 million students between 1975 and 1995.
3. Op. cit. *Higher education in developing countries: peril and promise*. pp. 28-29.

completion of education at the secondary level, or evidence of the attainment of an equivalent level of knowledge. These institutions, further classified in levels five, six and seven, comprise universities, teachers' colleges and higher professional schools.

The academic world often uses the operational *1987 Carnegie Classification*, which groups higher education institutions into categories based on the level of degrees offered, ranging from pre-baccalaureate to the doctorate, and the comprehensiveness of their missions.[4]

Although most of the rapid expansion in enrolment occurred in other categories, this paper focuses on the so-called *Research University* as the intellectual matrix and emblematic institution of any higher education system.[5]

The most striking manifestation of horizontal differentiation is the large growth of the enrolment share in private higher education institutions.[6] In Brazil, as in many other countries in Latin America, the private-public divide is an increasingly ideologically loaded issue. It also has a direct impact on the subject of this paper, as the level of the authority of knowledge varies dramatically along the divide. In the region, most research universities belong to the public education system, either federal or state. The latter is the case of the University of São Paulo, the most frequently cited example.

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4. The categories, established by *The Carnegie Foundation for the Advancement of Teaching* for higher education institutions in the USA, are as follows: Research Universities (I and II), Doctorate-granting Universities (I and II), Comprehensive Universities and Colleges (I and II), Liberal Arts Colleges (I and II), and Two-year Community, Junior, and Technical Colleges.
5. According to the *1987 Carnegie Classification*: "These institutions offer a full range of baccalaureate programmes, are committed to graduate education through the doctorate degree, and give high priority to research. They receive annually at least US$12.5 million in federal support and award at least 50 Ph.D. degrees each year."
6. According to Brazil's Ministry of Education, the number of private higher education institutions grew from 682 to 764 between 1980 and 1998, accounting nowadays for 62 per cent of the total enrolment.

The context

Brazil has the largest Science and Technology (S&T) sector in Latin America. It spends 1.24 per cent of its Gross Domestic Product (GDP) on S&T, a much higher level of expenditure than Argentina (0.5 per cent) or Mexico (0.42 per cent). For comparison purposes, Canada spends 1.59 per cent and the USA, 2.54 per cent of their respective GDP on S&T.

Researchers are mainly concentrated in academy (75 per cent) and government laboratories (17 per cent). The proportion of researchers in industry (8 per cent) is extremely low, compared to higher-income countries such as Canada (52 per cent) or the USA (80 per cent). Brazil's well-elaborated higher education system is, therefore, the major locus of S&T activity.

Academic research has been developing more rapidly than the world's average, and is internationally competitive in several fields. Out of the 20 countries, Brazil is the one to publish the most articles in refereed journals registered in the *Science Citation Index*. It should be stressed that, in spite of constituting less than 10 per cent of the higher education institutions, public universities (mostly federal and state) are responsible for 95 per cent of the publications abroad. An important reason for this performance is a solid graduate education system, which was established in the 1960s, with sophisticated accreditation and evaluation procedures.

Unlike the Spanish-speaking countries in the Americas, where Catholic universities were already established in the 1500s and 1600s, the first comprehensive Brazilian universities were created in the years that preceded the Second World War. Before then, universities had been merely an agglomeration of professional schools. The importance of the new universities was not limited to tertiary education *per se*, as stated by José Goldemberg, an internationally

renowned scientist and former Brazilian Minister of Education. "As is known, from the science and technology perspective, Brazil only ceased to be a colony, beginning in the 1930s, with the creation of the universities of Rio de Janeiro and São Paulo[7]". The latter, founded in 1934 by the appointed head of the State of São Paulo and a group of distinguished citizens, benefited greatly from the transfer of skills and knowledge of refugee scholars who escaped persecution, first from Germany, during the 1940s[8], and later from Austria and Czechoslovakia.

A watershed in Brazil's higher education system occurred in 1968, "When an educational reform was initiated in an attempt to reorganize it along the lines of the American model. This meant: the end of traditional chairs, the creation of departments and institutes; the introduction of full-time contracts, graduate education and credit system and the formation of close links between teaching and research."[9]

The higher education system in Brazil is quite pyramidal. The most recently published census, performed in 1998, found 973 institutions, with a total undergraduate enrolment of 2,125,958 students.[10] Among them, 153 are universities[11], almost equally divided between public and private, and approximately 10 per cent are research universities, according to the above-mentioned *Carnegie Classification*. Only two of them – University of São Paulo and the

7. Goldemberg, José. 1990. "O Presente Papel da Pesquisa Científica no Desenvolvimento Brasileiro". In: *A Nova Estratégia Industrial e Tecnológica: o Brasil e o Mundo da III Revolução Industrial*. Rio de Janeiro: João Paulo dos Reis Velloso (ed.). p. 135.
8. Saidel, Rochelle G.; Plonski, Guilherme Ary. 1994 "Shaping modern science and technology in Brazil. The contribution of refugees from National Socialism after 1933". In: Leo Baeck Institute, *Yearbook 1994*. Vol. 34. London: Secker & Warburg. pp. 257-270.
9. Schwartzman Simon; Balbachevsky, Elizabeth. 1996 "The academic profession in Brazil". In: *The international academic profession: portraits of fourteen countries*, Princeton: Philip G. Altbach (ed.). The Carnegie Foundation for the Advancement of Teaching. p. 234.
10. The census data are available at http://www.inep.gov.br/.
11. The conditions to becoming a university include: (i) institutionalized intellectual production; (ii) at least a third of the faculty with Master's or Ph.D. degrees; (iii) at least one third of the faculty on a full-time basis.

State University of Campinas – own more than 100 patents each, which is a common indicator of sensitivity to industry's needs. Both are public and belong to the State of São Paulo.

The University of São Paulo is the major landmark in Brazil's system of higher education institutions, with a strong qualitative impact on several areas of the country's economy and culture. The total number of regular students is 66,000 – 40,000 undergraduate and 26,000 graduate students; there are at least 90,000 additional continuing education students annually. Every year the university grants approximately 2,000 Master's and 1,500 Ph.D. titles, which makes this institution the major provider of qualified faculty for Brazil's higher education system at large. Of the 4,705 faculty members[12], 89 per cent have a Ph.D., and 78 per cent are full time – both figures are much beyond the requirements presented above.

The academic funding comes mainly from the State of São Paulo Treasury – approximately US$550 million per year.[13] There are no tuition charges for either undergraduate or graduate studies, nor is there university endowment, for the culture of philanthropy or charity is still incipient in Brazil.

A conservative estimate of the supplementary income – research grants a. 1 contracts, technological services, consulting, continuing education fees and other services – would increase the 'virtual budget' by US$150 million annually. This sizeable amount is difficult to precisely measure, as it enters the so-called 'enlarged university system' through a gamut of rather independent means. Such means

12. The male proportion – 68 per cent of the faculty – is even higher than the national aggregate figure of 60 per cent.
13. Since 1989, the three state universities of São Paulo have had financial autonomy, receiving a total of 9.57 per cent of the state tax revenue (with some adjustments); the University of São Paulo has the largest share, approximately 5 per cent. It should be noted that university expenses include retirement pensions for faculty and non-faculty staff, and the support of academic hospitals that provide health services to the neighbouring communities.

are: faculty and students in 35 teaching and research schools and institutes; 52 interdisciplinary specialized centres, institutes, and museums; 26 private not-for-profit foundations that help manage the interface between university and external social and economic environment, and 14 junior companies, managed by students.

This already points to an institutional characteristic of the University of São Paulo, which is a decentralized management system. It takes its roots in the very origin of the university, having successfully incorporated professional schools that had been established decades before. Based on a combination of norms, social contracts, checks and balances, the decentralized system works well most of the time, thus providing a flexible model for managing the interface.

Triadic models

The title of this study suggests the more general issue of interplay among the three classic dimensions of university end activities: teaching, research, and extension. Synergies and tensions arise from this multidimensional mission when extension is materialized in university-industry co-operation. They are to be discussed separately in terms of agenda building.

- First, the impact of the changing university-industry co-operation on the research agenda is addressed, highlighting the first of three major topics:

  (i) if and how it affects the type of research done in universities, albeit avoiding the classical dichotomy of basic-applied research;
  (ii) if and how it is possible to manage the inherent conflict

between openness, characteristic of the scientific community, and privacy/secrecy, which belongs to the world of business;

(iii) how it affects a major constituency of this type of higher education institution - the postgraduate students.

- Second, the impact on the teaching function is studied, mainly, but not exclusively, in terms of undergraduate programmes. This has traditionally been done along extreme lines. There is a feeling that only the beneficial aspect of co-operation with industries is stressed, e.g. bringing new influx of local cases into the classroom. Critics of links with companies focus on the fatal attraction of income generation - both institutional and private - as a major undesirable consequence. For instance, it robs experienced faculty members of contact with the younger student generation, as they get involved with the outside world. It might also affect the very nature of courses offered, shifting the balance from traditional education programmes to those that are more profession oriented. For example, intense discussion has been proceeding regarding the new type of 'professional Master's course', *vis-à-vis* the traditional Master's degree programmes. In other words, how sensitive should the university be to the voices of the market? Moreover, as a counterpoint, how can the university identify and benefit from opportunities to develop joint programmes?

In addition to end-activities, the relations of power intra-walls are changed as university-industry co-operation increases. Three main areas for conflict occur: between different academic fields, faculty and students, and academics and administrators. In the last case, it is important to state that the situation is unlike the successful university model of the USA, where there is a stratum of professional university managers. In Latin American public research universities, the senior administrators are faculty members temporarily removed from their academic duties, often

against their will, to perform the managerial tasks such as department chairs or deans.

- Academy-company linkages are strongly dependent on government inducement and support, constituting another triad. How do science and technology policies and programmes tackle this broader picture of closing the gap between knowledge generation and utilization? Some examples are provided from the very recent Brazilian experience.

University-industry co-operation and the research function

The most frequently asked question with regard to this subject is whether the co-operation with industry affects the university's research agenda. With the *caveat* that a large research university has multiple agendas rather than a single one[14], the answer with regard to important research groups is a clear affirmative.

This was also the result of a thorough study of 36 internationally competitive research groups in physics, chemistry, and engineering - 18 from the São Carlos campus of the University of São Paulo, and 18 from the Federal University of São Carlos.[15] Two major factors taken into account by researchers, when defining their actual research lines, were the expectation to generate practical results that might be applicable, and the desire to develop something useful to society.[16]

Performing contracted or co-operative research contributes to the fulfilment of these goals. Moreover, Brazilian Government grants for research, both at the federal and the state levels, are increasingly

14. There is a large stone inscription in the main square of the University of São Paulo's largest campus stating: "In the universe of culture, the centre is everywhere" (in the original, "*No universo da cultura o centro está em toda parte*".
15. São Carlos is a middle-sized city in the State of São Paulo, 250 km. from its capital. The concentration of researchers and technology-intensive companies allowed them to market the city as "The Technology Capital".
16. Vitale Torkomian, Ana Lucia; Plonski, Guilherme Ary. 1998. "*Aproveitamento da Pesquisa Académica na 'Capital da Tecnologia'*. In: *Proceedings, XX Simpósio de Gestão da Inovação Tecnológica*, 17-20 November: University of São Paulo. p. 720.

tied to a pre-existing agreement between the academic research group and industry, with a resultant sharing of the cost, usually at a minimum level of 30 per cent.[17]

The immediate set of questions concerns values, e.g. if this interference in the research agenda damages the social value of the intellectual freedom of the university. The point issue is emphasized when the case involves publicly funded universities in a country with limited human capital and scarce financial resources. There are many points of view, as it is most evidently a 'loaded' issue.

Marilena Chauí, a sophisticated thinker and outspoken faculty member of the University of São Paulo's Department of Philosophy, provides a thoughtful answer. She departs from a broad concept of democracy[18], which leads to the recognition of fundamental differences between need, privilege, interest and right. "Needs and privileges are specific and particular; interests are general for different groups and social classes; rights are universal".[19] Professor Chauí elaborates on these distinctions and concludes that, in a democracy, public universities should address the ***rights*** of the citizens, which are universal, rather than focus on the satisfaction of ***interests***, either of business corporations or of the academic corporation. Among other reasons, if it chooses to promote the interests of any corporation, the university has to prove that some interests are more legitimate than others.

17. This is the case of the Partnership for Technology Innovation (in the original, *Parcerias para a Inovação Tecnológica* – PITE) programme, established by Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP, the most respected state S&T funding agency.
18. Professor Chauí frames her argument in the concept of democracy as not only a political regime based on law and alternation in government by means of contest between political parties, but also as a general form of existence based on the creation, recognition, and guarantee of rights and duties for the citizens.
19. Chauí, Marilena. 1995. "Em Torno da Universidade de Resultados e de Serviços", *Dossiê Universidade-Empresa*. Revista USP 25, p. 61.

Some critics of university-industry co-operation are subtler. For instance, based on the ingrained dichotomy between basic and applied science[20], these critics stress the need for the university to concentrate on the former. This somewhat Manichaean viewpoint[21] has been fading, as there is an increasing fuzziness between the two types of research, e.g. in molecular biology. The perceptions of most of the 36 research groups of the previously mentioned São Carlos study follow the same line along a blurred border between basic and applied research.

Donald Stokes recently put forth a constructive approach, under the attractive name of *Pasteur's Quadrant*. Niels Bohr, making the assumption that scientific knowledge is always useful at a particular point in time, builds a convincing case that recognizes the importance of use-inspired basic research – e.g. his model of the atom. Moreover, relevance to the advancement of knowledge and to short and medium-term application of science should be seen under combining rather than exclusive categories. This is demonstrated by Pasteur's paradigmatic work, which made relevant contributions both to the creation of a new scientific field (microbiology) and to powerful immediate applications in industry and health services.[22] The main ideas behind Pasteur's quadrant have good, albeit not universal, acceptance in the mainstream of Latin American academia, as local examples of good scientific research combined with usefulness to industry abound.[23]

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20. Vannevar Bush asserted the dichotomy between basic and applied science more than 50 years ago, when he released his enormously influential report, *Science, the Endless Frontier*. This view was at the core of the covenant between the USA Government and science that led to the golden age of scientific research in that country after the Second World War, a covenant that is being reshaped.
21. The tension is even more evident when the expression 'basic science' is substituted by 'pure science' – as the parallel to 'applied science' would become 'impure science'.
22. Stokes, Donald E. 1997. *Pasteur's Quadrant: basic science and technological innovation*. Washington: Brookings Institution.
23. Two successful cases in FAPESP's PITE programme are: (i) a set of new phosphate-based inorganic and hybrid pigments, which substitute for millions of dollars of formerly imported pigments in the paint industry; and (ii) the design and implementation of a Portuguese automatic grammar reviser by an interdisciplinary team of researchers from linguistics, computer science, and other fields, which is now part of the most popular brand of PC suite.

University-industry co-operation and the teaching function

The question of whether university-industry co-operation affects the teaching function also receives a clear positive answer on the undergraduate, graduate studies, and continuing education levels.

Three major categories are established on the basis of scores of examples of university-industry synergy on *undergraduate level* teaching in Brazil.

- The first, quite common, concerns internships. Students are required to obtain practical experience as part of their learning process, and companies are a usual locus for apprenticeship. It should be noted that there are qualitative differences in the implementation of the concept of internship, forming a continuum. On one extreme, students are used as cheap replaceable labour and, on the other, internship is seen as a major headhunting activity, in order to attract the most talented students.

  The potential of this type of synergy is stressed in the Co-operative Engineering Degree Programme at the University of São Paulo's Polytechnic School, established in 1989, inspired by the experience of Waterloo University in Canada. The underlying concept is that students should be exposed to both academy and industry very early in their engineering course. In practical terms, university students alternate four-month periods at the university with time spent within companies that adhere to the Programme. The industry periods are organized in such a way as to provide a structured learning frame, whereby students are gradually exposed from simpler to more complex professional challenges.[24]

24. The pilot programme was installed in Cubatão, an industrial city one hour away from the main campus. The idea of merging the innovative model with the extension to another city had unsuccessful results, as the municipality did not fulfil its promises regarding the construction of suitable facilities (including laboratories) for the academic periods. Currently in the main

- The second category is characterized by active involvement of undergraduate students in advisory activities or specific projects for industry. This is illustrated by Dial-Technology (USP™), in the original *Disque-Tecnologia* (USP℠), a pioneering service established by the University of São Paulo to mainly provide support to small companies.[25] Under supervision, students address simple cases of technological or managerial problems of very small companies, alleviating the demand on faculty, which otherwise usually finds unwelcome repeated requests of a similar nature.

  This type of activity has influenced the expansion of junior companies at the University of São Paulo, which have augmented from 2 to 14. These enterprises, inspired by a French model, are managed and staffed by undergraduate students. They develop projects (under technical supervision of faculty) to different clients - companies, government and NGOs - constituting a fruitful ground environment for the development of both specific and general professional skills and attitudes.[26]

- The third type, currently growing very rapidly in Brazil, is related to the organized effort to promote student entrepreneurship. This overarching programme comprises a number of initiatives, such as including entrepreneurial-related topics as part of the formal

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campus, the Co-operative Course has been renamed *Curso Quadrimestral*, stressing the four-month alternate periods - five on campus and four at industry sites, as opposed to the traditional semester programme. On one hand, it might be questioned why the former inspiring name was abandoned. On the other, the decision stresses the fact that there are also many forms of successful industry-university co-operation in the traditional engineering courses.

25. The service was created in 1991, and had already provided support to 18,000 companies and new entrepreneurs. It has the financial backing of the São Paulo State branch of the Brazilian Micro and Small Company Support Service (in the original, *Serviço Brasileiro de Apoio às Micro e Pequenas Empresas* - SEBRAE). It has been replicated in 16 other institutions, mostly academic, in Brazil and in Argentina.
26. Junior companies exist in many higher education institutions in Brazil, organized by state federations. At the University of São Paulo, students of the Polytechnic (Engineering) School and of the Economics, Management and Accounting Faculty formed the first two. Junior companies were also established in less evident fields, e.g. by students of social sciences. In this case, some of the projects are contracted by industry, for instance to perform marketing and other surveys that require sound quantitative methods.

curriculum, and the establishment of high-tech business incubators.[27]

University-industry co-operation is relevant to *graduate studies* mainly because of the research agenda setting already discussed. Another important issue is the opening of the university to graduate students already employed by industry. In spite of their taking more time to complete the Master's[28] or, in some cases, the doctoral programme, they provide an invaluable bridge between industry and academia, developing a unique perspective from both sides that enables them to act as informal brokers.

On the other hand, direct sponsorship of graduate students who are not employed by industry is somewhat less frequent in some universities, as opposed to others in advanced countries - mainly the USA.[29] This situation is akin to the fact that endowed chairs are a very rare phenomenon in the Brazilian academic landscape.

Continuing education, which is increasing its economic and social importance as people have two or more careers during their professional life, has a direct reciprocal relationship with university-industry co-operation. It is a basis for other modes of university-industry co-operation, as it provides for a common intellectual ground between academia and business. This exceptional space has yet to be better explored by most Latin American universities, which

27. The national benchmark is the Genesis Project of the Rio de Janeiro Pontifical Catholic University, one of the few private research universities in Brazil.
28. The Master's degree in Brazil follows the European model, requiring an extensive thesis which is publicly examined by three professors. Completing the Master's degree is a condition to be considered for doctoral studies. A Professional Master's degree has recently been authorized by the educational authorities, in order to provide an option for professionals pursuing advanced knowledge, but without the desire or condition to write the thesis.
29. The graduate studies are completely free of charge in the Brazilian public university system. However, graduate students need grants in order to dedicate themselves full time to their studies. The main sources are Federal S&T funding agencies.

normally have separate managerial structures for continuing education and technological partnership.[30]

Continuing education irrigates and nurtures graduate studies and undergraduate teaching. This is done in three ways:

- by means of financial resources, as continuing education courses usually charge fees;
- by bringing technology-intensive pedagogical resources into the classroom, such as distance education;
- by providing teaching examples and fieldwork opportunities.

Overall, there are several problems with regard to co-operation with companies for university teaching. The most criticized aspect in Brazilian public universities is the competition for the faculty's time; they are sometimes accused of dedicating a large portion of their energy to the careful preparation and permanent updating of well-paid continuing education courses, in contrast with a 'second-class' approach to the regular teaching load included in the relatively low salary.[31]

The time expenditure of undergraduate students has also been a recent problem. Precocious unplanned internships in well-paying intense working environments, such as financial companies[32], make young and otherwise good students dedicate less than adequate time to academic life. This problem is evidently magnified by the trend of young students to create e-ventures.

30. One of the good examples of synergy between the two structures is the Pontifical Javerian University, in Santafe de Bogotá, Colombia.
31. University of São Paulo, for example, puts an annual ceiling of 72 hours of paid continuing education courses for full-time faculty, in order to avoid exaggerated dedication to 'external interests'. These hours cannot be included as part of the minimum eight hours a week teaching load.
32. A visible sign is the number of very young students dressed in business attire, anxious to leave the class in order to get to their 'job'.

The traditionally clear boundary between academy and industry has also been blurred by the teaching function, which has raised some delicate questions. For instance, when are courses in risk of becoming mere showcases for proprietary products? It is also worth while to follow up the complex web of interests that develop around the phenomenon of corporate universities, many of which establish a close relationship with traditional universities.[33]

Another perceived problematic aspect is the gap that persists between teaching infrastructure for continuing education programmes, upgraded with the help of charged fees, and the regular undergraduate and graduate classes, which depend on the university's basic budget.[34]

University-industry co-operation and institution building

Co-operation with industry contributes to a set of strategic opportunities for universities, requiring a systems approach in its management, in order to make good use of them, while maintaining the internal cohesion of the academic community.

The first question that needs to be addressed is the income differentiation among faculty, in the environment of isonomy that prevails in Brazilian public universities. While maintained formally, within the three São Paulo State universities, isonomy was made flexible *de facto* at the end of the 1980s, when the '80 to 20' rule for the use of time was passed.[35]

33. The author is advising a doctoral dissertation focusing on corporate universities.
34. The differences are often as evident as the distinctions between classes in a commercial aeroplane.
35. The 80-20 rule allows for up to eight hours a week of paid extension activities, under certain conditions (namely, disclosure and payment of some internal fees).

The second issue is related to university foundations, which are private specialized structures to manage the interface with industry (and, in general, with any outside contractor). Instituted since the 1960s, as a way of adjusting the speed and flexibility of academic administrative procedures to the needs of contracted projects, foundations have a long history of very positive achievements. However, they are rejected by some segments of the university community as a foreign body. It is a veritable art to maintain the social contract between the foundation and the main academic stakeholder.[36]

The role of government

The role of government in what are now called National Innovation Systems (NISs) has been recognized in Latin America since the 1960s, when Jorge Sábato and Natalio Botano proposed a model using science and technology to overcome Latin America's state of underdevelopment.[37] Known as *Sábato's Triangle,* this normative model proposed the establishment of strong interrelations among three players in a given nation, namely its S&T infrastructure (universities, public and private R&D centres), productive structure, and government policies. Each one is to be represented by a vertex in a triangle, the last one being on the top.[38]

Dramatic changes in regional politics and economics were necessary before the recommendations could enter the agendas of

36. The equilibrium is helped by a steady financial flow from the foundation to the university stakeholder (department, school, or central administration). This is by no means a sufficient condition, as issues of control and power are central. The rupture between the Minas Gerais Federal University's School of Engineering and its highly successful Cristiano Otoni Foundation is a paradigmatic case.

37. Sábato, Jorge; Botano, Natalio. 1968. "La Ciencia y la Tecnología en el Desarrollo Futuro de América Latina". In: *Revista de la Integración*. November: pp. 15-36. The strategy proposed was "the insertion of S&T into the web of the development process."

38. The strategy devised by Sábato and Botano would result "from the multiple and co-ordinated action of three fundamental elements for the development of contemporary societies: government, the productive structure and the S&T infrastructure".

the three actors, almost a quarter of a century later. This has been especially true with regard to the interaction between the S&T infrastructure and the productive sector - two elements that constitute the base of *Sábato's Triangle*.

Governments, to induce co-operation, are working out economic and legal frames. These mainly consist of the following:

- tax incentives for R&D;
- special grants for academic research groups that co-operate with industry;
- soft financing for contracted or co-operative R&D projects;
- state and private venture-capital firms;
- stimulus for incubators, high-tech parks and technopoles;
- update in the intellectual property rights laws - to include sensitive areas such as food and health products, and genetically engineered forms of life.

These are having powerful effects. For instance, the US$1.9 billion in R&D programmes committed by industries and agriculture during 1993-1997 in Brazil, under tax incentive Law 8661, brought about many opportunities for creative forms of co-operation.[39]

The outstanding genome sequencing initiative sponsored by FAPESP and industry associations is a recent example. In partnership with FUNDECITRUS, an orange growers' association, which had been created to deal with plagues that affect their crops, established a project requiring an investment of US$13 million, and involving 192

39. One example is *POEMA* ('poem' in Portuguese), an acronym for an R&D co-operation project between the Mercedes Benz local subsidiary, the Federal University of Pará, and organizations of small producers of ***babassu*** (a Brazilian palm tree) and other natural products, which are now being used to 'tropicalize' auto-parts.

researchers in 35 laboratories (half of them from the University of São Paulo). The result, completed ahead of time in January 2000, was the complete genome sequence of *Xyllela fastidiosa*, a bacterium that causes citrus variegated chlorosis, a disease that threatens the entire citrus industry in São Paulo State, the world's largest exporter of concentrated orange juice. The disease affects more than 30 per cent of the total tree population and causes losses estimated at US$100 million each year.[40]

A unique role of government to foster university-industry co-operation is to support co-ordination of long-term S&T policy decisions taken by the actors of the NIVs, by means of providing Foresight studies' results.[41]

Conclusion

This paper concludes with the recommendation to avoid minimizing controversies related to co-operation with industry, which tend to increase proportionately to the height of stakes in potential profit from research. Therefore, each university should establish checks and balances, along with incentives and professional management, in order to promote a sustainable co-operation.

The underlying concept for sound administration of co-operation is knowledge management, which includes, but is not limited to,

40. The scientific, technological and institutional importance of this co-operative effort on the frontier of knowledge was recognized internally, by the government and society, and externally, e.g. in an article published in *Science* on 5 May 2000 under the expressive title of 'A genome Cinderella story'.
41. Brazil's Ministry of Science and Technology received the support of the World Bank to perform the first comprehensive Foresight study, which was commissioned in 1996 by the National Council of Science and Technology. Nevertheless, the study was postponed, for internal reasons, for more than a year.

intellectual property rights.[42] The preparation of professional interface managers, which is a basic requisite, can be benefited by PROTEU, which is the acronym in Portuguese for the Training Programme to Develop Competences for University-Industry co-operation managers.[43]

Guilherme Ary Plonski is the University of São Paulo's Executive Co-ordinator for University Co-operation and Member of the Board, Centre for Technology Policy and Management.
E-mail: plonski2@usp.br

42. An international round table on this subject was held as part of the preparation of a special issue of the University of São Paulo's Management Journal on university-industry co-operation. The Euvaldo Lodi Institute, the specialized body from the National Confederation of Industry for promoting co-operation with academy, sponsored this issue. The minutes are found in Leme Fleury, Maria Tereza (co-ord.). 1999. 'Mesa-redonda: A Relação Universidade-Empresa – Desafios e Oportunidades na Geração e na Disseminação do Conhecimento', ***Revista de Administração***. 34 (4). pp. 32-45.
43. PROTEU is also a mythological entity, characterized by refusing to tell what it knows, and by rapidly adjusting to changes. PROTEU was created by the University of São Paulo's Institute of Management Foundation, with the support of ***Financiadora de Estudos e Projetos*** – FINEP, a major financing agency of the Ministry of Science and Technology, and of the Ibero-American Network of Industry-University Co-operation Management – CYCOOP, which is part of the CYTED Programme. Managers from most Latin American countries, as well as from Spain, have attended since 1995.

IN RESPONSE TO THE PRESENTATION OF GUILHERME ARY PLONSKI

by Deputy State Secretary Carl Lindberg

Mr Ary Plonski based his study primarily on the Brazilian situation in general, and on the University of São Paulo in particular, throwing an interesting light on the relation between universities and industry. This was of special interest to me, coming as I do from Sweden, since we also have a situation where universities and university colleges are mainly state controlled. Their primary task is to ensure that the results of their education and research programmes are beneficial to the whole population and not limited to serving specific commercial interests.

Mr Plonski has brought to the surface some important issues. Whether and in what way the research of a university is influenced by closer co-operation between the university and the business sector? Closer co-operation certainly entails a number of both desirable and undesirable aspects. A few years ago, the Higher Education Act (HEA) was modified in Sweden so that, in addition to the two original functions of higher education, which were education and research, a third was added: *co-operation with the community*. This refers not only to the business sector, but also to the various bodies within the public sector. Co-operation also means that both parties mutually influence each other, are of use to each other and benefit from a mutual exchange of ideas. To be able to co-operate, the university must open its doors to the surrounding community and allow the needs and ideas, that spring from its new contacts, to become the object of critical reflection and, where relevant, be integrated into teaching. This does not mean that the university has to lower its standards of integrity based on academic freedom, i.e. the right of individual researchers to choose the object of their research and to be responsible for the results. On the

contrary, it is in everyone's interest that openness and freedom in research processes are maintained and that the results of research are published as soon as possible, for the benefit of all.

However, as Mr Plonski mentioned, an inherent conflict exists between the academic ambition for openness and the desire of the business sector commissioning research to keep the results secret. For many years, we have upheld the principle in Sweden for the right of the researcher to his own findings, despite the fact that staff employed by universities have performed them. This principle is not, however, incompatible with the government's wish that new inventions and findings be more actively commercialized.

On the contrary, we believe that such commercialization is precipitated by the fact that the individual researcher is entitled to his results. If the researcher wishes to enter into an agreement with the university in order to obtain support in specific matters, such as applications for patents or for further development of an invention, in return for the university receiving part of the possible profits of such commercialization, this is naturally permitted. Where research work is directly commissioned and proceeds in collaboration with a business company, there is, of course, the possibility to come to an agreement whereby a minimum time is set between a finding and its publication, in order to enable the company to investigate whether or not the research results are patentable. In such agreements between the researcher, the research institution and the commercial party, a time limit of three to six months is normally set so that a patent application may be submitted. After this, the researcher is free to publish his results.

It is of course especially important to have distinct agreement between parties involved in the case of students working on a research project. A research student has a particularly keen interest in publishing research results as soon as possible and it is thus important not to thwart him/her in this ambition. On the other hand,

research students also have much to gain from close co-operation between the university and business sector. If they become Ph.D. students for industry, they will acquire many opportunities to acquaint themselves with research environments, within both the university and industry systems.

Mr Plonski described the ways in which teaching at the basic educational level may be influenced by greater co-operation between universities and industry. There may also be conflicting interests, one being that companies and their employees are interested in influencing the basic choice of educational programmes, which in my country are completely free, so that they are in line with the persistent needs of employees of continuing professional development. We also find, in contrast to the situation of continuing training, the need to train young people and adults who have never benefited from even very basic education. Broad national and/or political priorities are indispensable in working towards the discovery of a solution to this problem.

Another cause of contention may be the conflicting interests between courses conceived for employees and financed by companies, and those that are normally part of the basic educational programme. University teachers may be eager to obtain extra income for their institution or for themselves, which could endanger the quality of teaching that the ordinary student has the right to demand. We are trying to reduce these conflicts of interest, partly through governmental regulations and partly through the fact that Swedish students and their organizations are strongly represented within universities at different levels and even on university governing boards. They are thus in a position of considerable influence, should they feel that their rightful interests are being threatened.

It is extremely important that everything possible be done to guarantee openness and public control within education and

research. For this reason, there are rules in Sweden requiring university teachers and researchers to reveal any sideline occupations related to the subject area of their work. A university member of staff is naturally entitled to a part-time job outside his/her main work domain, but this does not allow him/her to abuse the situation, thus undermining public confidence in the university. It is being suggested now that research staff should always reveal their economic connections. All in all, this would reduce the risk of inappropriate pressures and simultaneously contribute to maintaining public confidence in research and education. It would also fit in well with the Swedish tradition of openness, manifested in the principle of public access to official documents, which authorizes all citizens to consult public records.

Mr Plonski also discussed the issue of how relative strengths are influenced within the university among different academic fields and among teachers and students. I believe that the keen interest in natural sciences and technical subjects on the part of the business and industrial sector, will inevitably lead to pressure being put on research, particularly in these fields. A positive aspect of this is, of course, an influx of enormous resources that will benefit research and strengthen its scientific base. However, we must not close our eyes to the fact that considerable tensions and difficulties involving co-operation may also arise when certain research staff are able to benefit, perhaps even personally, from large increases in resources, while others are left out in the cold. Here, university administrations bear a great responsibility in creating means by which these additional resources can benefit all teaching and research staff.

I would like to close by thanking Mr Plonski for his interesting address and for being given the chance to put forward reflections about how my country regards some of the issues on which he chose to focus.

PART III

IN WHAT WAY DO CHANGING UNIVERSITY-INDUSTRY RELATIONS AFFECT THE MANAGEMENT OF HIGHER EDUCATION INSTITUTIONS?

by Michael Lewis Shattock
Visiting Professor at the University of London Institute of Education

INTRODUCTION

Governments, certainly in the United Kingdom, have worried about the effectiveness of university-industry links, at least since the 1950s, but this concern has now become almost worldwide, as the long-forecast transformation of the industrial scene from labour-intensive manufacture to knowledge-based industry has taken place. There is now a considerable amount of literature about university-industry relations in the new configuration. The literature refers regularly to the 'triple helix' of university-industry-government relations (Etzkowitz, 1998) and to 'mode 2' interdisciplinary research (Gibbons et al., 1994) or to concepts of 'entrepreneurial science' (Etzkowitz and Webster, 1998). There is growing interest in universities' regional impact, universities' role in wealth creation and in the 'capitalization of science', and in the effects of globalization and localization. At the same time universities, facing severe reductions in their unit of resource of state funding, are becoming much more market aware and conscious of the need to generate non-state resources. Some are also becoming much more global in their ambitions both in teaching and research. It is not the purpose of this paper to review the literature about these developments, but it is necessary to highlight the conceptual changes which are taking place in order to see how they impact on the managerial and organizational consequences within universities and industry.

These changes in the context of university-industry links are having, and will have, significant impacts on the organizational forms through which they are managed. But to understand these new structures better, it is useful to consider the kind of traditional structures of management which, at least in the United Kingdom,

have been used to maintain links between universities and industry. Under this model, universities were funded for teaching and research by the state and looked to industry either because they needed more funding, or because industry offered interesting research problems that individual academics were keen to tackle. Another reason for university interest was that industry often had experimental facilities, equipment or testing facilities not available in university laboratories. Industry, on the other hand, conducted much of its own R&D but recognized the value of outsourcing a good deal of its more upstream research to university laboratories and valued the opportunity of bringing complex problems to universities where leading academics might be found to solve them. The characteristic arrangements were for research contracts to be signed between individual companies and universities to carry out a particular research task, or for individual academics to be offered consultancies with companies either for particular projects or to act as a general referral point for problems. Universities appointed industrial liaison officers (ILOs), usually with strong industrial backgrounds, to maintain links with industry, facilitate links between academics and companies and to act as 'midwives' for research projects of various kinds. Companies also appointed university liaison officers for the same purpose, although these officers often had recruitment roles and made separate links with career officers in universities for this purpose. R&D was seen as a linear process in which basic research led through applied research into development. Universities did the basic and some of the applied research, and companies did the rest. Relations were essentially one to one, a single company research director with an individual academic. The key was how the former knew of the congruence of academic interest with an industrial problem, or how the latter assessed potential industrial interest in the direction of his or her research.

In this kind of environment the industrial liaison office was often sited on the periphery of the university campus and the ILO was left much to his or her own devices, preparing information brochures, advising individual academics and companies, and visiting companies to keep abreast of industrial developments.

Of course it was not always as simple and tidy as this, and through the 1980s, under the pressure of the Thatcher reforms, the ILOs became more proactive, more interested in a professional technology transfer role, more concerned with identifying intellectual property, patenting it and licensing it. As government began to see evidence of industrial collaboration as a performance indicator, the role of the ILO was energized and given more central focus. As the scale of industrially related research grew, the question of the level of overhead charges, or indirect costs, that needed to be levied became more important, especially as state-funding levels declined. At Warwick, the Technology Transfer Office was merged with the part of the Finance Office that was responsible for the financial side of research grants and contract administration with a view to creating a Research and Development Services Office. This office was responsible both for negotiating overhead levels and accounting for research contract income, as well as for the overall central research management function, which had grown enormously because of the extent to which success in research (often equated with the size of overall external research income) was defining the long-term status and profile of the institution.

However, this organizational structure only represents a small, if any, element of what is required today. Before considering this, it is necessary to discuss what changes have been taking place in the research interfaces between industry and universities.

The growth of Mode 2 research

The linear model of the staging of pure-into-applied research and then into development has become outdated, in part because of the pressure of competition which compresses the time available for the commercialization of research ideas, and in part because commercialization or the development of real products demands an interdisciplinary approach. Gibbons defines Mode 2 research as "where discovery and application are more closely integrated" (Gibbons et al., 1994). Commercialization, he suggests, "is organized less around the translation of discoveries into new products than in searching for design configurations with the potential for development" (Ibid.). Increasingly it is not a problem of generating new discoveries, but of making use of the knowledge base that is already available; so the new approaches depend less on basic science and more on the application of knowledge for wealth creation.

The changing industrial context

Single company to university laboratory relationships are being overtaken by pre-competitive consortia or clubs of companies, and sometimes governments, who commit resources and manpower to work with one or more universities on closely targeted R&D, pooling equipment and research expertise. This can involve industrial and university teams working together in the same laboratory or unit with much greater urgency and 'near market' sense of mission than in the past. Under such arrangements "knowledge production is characterized by a closer interaction between scientific, technological and industrial modes of knowledge production, by the weakening of disciplinary and institutional boundaries, by the emergence of more or less transient clusters of experts, often grouped around large projects of various kinds, and by the broadening of the criteria of quality control and by enhanced social accountability" (Ibid.). In this

sort of world, networking is of critical importance; the days of the single expert or the single point of contact within a university are gone.

The changing role of governments

The recognition of the critical role of the knowledge-based industries for national economies has led to much greater priority being given by national governments and the EU to what Etzkowitz has described as the triple helix of government-industry-and the universities. "Fundamental changes occurring at organizational and institutional levels within and between university, industry and government, constitute a new environment of innovation replacing the linear model. Bilateral government-industry and university-industry ties have expanded into trilateral relationships at the regional, national and multinational levels. Encouraged by government, universities have become a key element in innovation policies throughout the world..." (Etzkowitz and Leydesdorff, 1998). Machinery like the Foresight Exercise, industrial fora, and so forth, play a much greater role in determining government investment into science than advice from the scientific community *per se*. The key collaborations are based on partnerships rather than contractor-research relationships.

The development of regional roles

Goddard and others have drawn attention to the importance of universities as key agents within regional economies, linking with local and regional government and with industry (Goddard, 1999). The growth of Science Parks, local industrial fora, membership of regional development agencies, all bear testimony to the extent to which universities all over Europe are playing an increasingly

significant role in attracting knowledge-based companies to the area or spinning out new companies from amongst their own researchers.

Lundvall has written about the learning economy, emphasizing the "importance of interactive learning as the basis for innovation and change in modern developed economies" (Lundvall and Johnson, 1994) and Goddard has extended this to raising the concept of "the learning region" (Goddard, 1999). In the author's case study of Warwick, in the *Journal of Industry and Higher Education*, there is a description of how the Warwick Manufacturing Group has combined creating a learning environment with industry in the British West Midlands with highly interactive Mode 2 research, and has used this as the base for a global research, development and training portfolio (Shattock, 1997). Again, Kantor has described the regional-global axis, the way universities can attract global interest in a region and the way global companies can transfer technology and research outcomes around the world (Kantor, 1995).

The rise of the research centre in universities

These external demands have had an increasing impact on university-academic organization. Where once the academic department reigned supreme, based on a single discipline and, at least in the Anglo-Saxon world, teaching a single degree discipline, academics are increasingly grouping themselves in cross-departmental research units or centres in order to tap into the new research markets. In the UK, the government has encouraged this development by pump-priming special interdisciplinary research centres and inter-university partnerships in specific research areas. In the USA, Etzkowitz and Kenelgor have written about "the collectivization of academic science" (Etzkowitz and Kenelgor, 1998) and have shown how a research centre can develop much closer

links with external contractors, even to the extent of forming its own companies, than research groups operating within departments. They cite intensified competition in fast-moving fields and "the realization that a practical or theoretical problem can best be attacked by a group of investigators drawn from several disciplines". However, 'leaders' and academic entrepreneurs create centres, and their success depends a great deal on generating external funds and industrial contracts. Indeed, they often simulate some aspects of industrial research laboratories, buying in on a short-term basis skills not possessed in the centre, sharing valuable equipment and providing 'neutral ground' in which company collaborators can work with university staff. Such centres often offer immediate research access to companies via company subscriptions, industrial clubs and regular seminars/fora for external members.

These external and internal changes have revolutionized the organizational structures that universities formerly had in place to interface with industry. Inevitably they demand a new range of skills: the ability to build networks, a capacity for brokerage, a wider vision about the university and the economy, strategic skills in identifying and marrying market niches and gaps and university research strengths, legal and intellectual property skills, skills in company formation and a broad appreciation of industrial training requirements. Where you have powerful research centres relating to industrial problems it is likely that the specialist expertise in the research centre far outweighs in effectiveness any liaison skills that can be provided centrally by the university industrial office. Thus, as industrially funded or Mode 2 research expands in universities, research centres take over many of the functions that were previously located in the industrial office in the centre of the university. Inevitably, therefore, the situation becomes much less tidy; more tension can be generated between university central authorities and

academic entrepreneurs in academic departments and research centres, and questions of co-ordination, adherence to university regulations, and recognition of success in terms of the allocation of institutional resources or of a financial return to the institution become issues of great sensitivity.

It is not possible to provide easily applicable solutions to these difficulties, especially when university circumstances, funding arrangements and commitment to a particular range of disciplines are so various. But what this paper will try to do is to outline some of the range of organizational arrangements that universities have adopted to face up to the changes in the external world and to try to identify some of the internal issues, most of which are financial and motivational, which universities must now address.

▪ Organizational issues

It is clear from the above description that the monolithic set of structures that universities previously employed to relate to industry are now no longer relevant and increasingly successful universities are adopting a range of organizational instruments to relate to the industrial world.

▪ Science Parks or incubator facilities

The recognition that regional economies need stimulation from knowledge-based companies and that academic entrepreneurs, if they are to be loosely retained within a university structure, need independent space and facilities to develop company formations, has led to many universities establishing Science Parks or company incubator units on or adjoining their campuses. There are of course a wide variety of such developments and the author is not going to attempt to describe them all. A significant number of universities

have now established incubator facilities which provide space and support in terms of some common services in order to assist researchers to establish viable businesses based on their research findings. Some universities have, in partnership with external financial bodies, set up venture capital agencies, which will invest in such ventures. Warwick and Birmingham Universities, for example, successfully bid for government funds to set up an exploitation fund, in partnership with a private investor, which is to be run like a private-sector venture capital company under a company board, with a chairman and a chief executive appointed from outside. One of the advantages of this particular arrangement is that the fund will invest in research which shows promise of producing a commercial outcome, rather than, as would be the case with a normal private-sector venture capital company, only when the research is ready for exploitation.

Frequently universities are now themselves prepared to invest in companies founded by researchers by taking equity in the company formed. There are arguments for and against this from a financial point of view. Obviously the university is showing faith in its staff by doing so and is also seeking to realize the intellectual property rights it can legitimately claim if the research has been developed on its own premises by its own staff. (Sometimes indeed the equity it claims can simply represent the resources it has put into the research in the past). On the other hand, however, start-up companies normally require successive ***tranches*** of investment to turn a research finding into a profitable business and skills in management and marketing become more important than the value of the original research, so that a university can often find itself sucked in to successive rounds of investment without the secure prospect of any financial ***recoupement***. Moreover, universities are more susceptible to being persuaded by their own staff, rather than by a commercially aware

venture capitalist that has shareholders to answer to. The Warwick experience is cautionary here in that it made an investment in a biotechnology company launched by one of its academics on the University Science Park some 12 years ago. The company is still alive, has secured successive rounds of venture capital funding so that its value is much higher than it was initially, but the university's equity share has fallen to a very small proportion of the total share value. If the company were to be sold, the university might realize its investment, but it is unlikely and even if the company goes into production and becomes a really profitable business (which the initial research idea suggested it certainly would do) the odds are against the financial return to the university being better than if it had invested the sum in more conventional ways.

The importance of a Science Park may be much less as a vehicle for launching university-based companies, than in attracting knowledge-based companies to locate on a site adjoining a university and becoming partners with departments, centres or individual researchers in research and development. Again the Warwick experience is instructive in that its Science Park, founded in an area of industrial decline, has attracted R&D-based companies from the USA, France and Germany, as well as from within the UK. The Warwick Manufacturing Group in the School of Engineering has, in particular, developed research and development partnerships of considerable size and importance. The Park has developed incubator facility offshoots (or colonies) in the surrounding region, which has greatly widened the university's links with high-tech SMEs. More important, the Park has widened its remit to provide summer placements for students in Science Park companies (and others). It has set up a 'business angels' fund (that is, a club of investors in SMEs), which is able to fund SME start-ups, or SME refinancing arrangements, anywhere in the West Midlands. It has also established links with

Science Parks in other European countries, which has facilitated company-to-company partnerships' bidding for EU investment.

■ Exploitation of companies

What a successful Science Park can do, is offer an additional dimension of industrial links, which can develop in a variety of ways. A complementary development is the creation of an exploitation company, of which ISIS in Oxford is a good example, which is charged to undertake, on a university's behalf, the commercial exploitation of its research. Some universities require that all exploitation pass through such a company; others set it up in such a way that it must sell its services to the academic community, in competition with existent private-sector bodies. Such a company, which will have access to investment funds contributed to, in whole or in part, by the university, will use its resources to safeguard and exploit the university's intellectual property interests in terms of patents, licences and royalties. It will serve as a venture-capital arm to invest in companies growing out of university laboratories. The problem for exploitation companies is the size of the business they can generate. ISIS, at the University of Oxford, has world-class science and technology, involving several thousand members of staff and research students, who are capable of producing a significant range of intellectual products. However, the record of other exploitation companies has not necessarily been so good, especially in universities where the science base is much smaller, or less geared to leading-edge fields like biotechnology.

Such companies can also have a role in marketing and developing consultancy for university staff, where the consultancy payments are made to the company, on an agreed profit-sharing basis, with the staff concerned. Many universities have companies almost solely for this purpose, partly because it creates a framework in which academic

consultancy to business can be regulated, and occasionally developed into more formal institutional partnerships. Such an arrangement is valuable to the academic, taking into account the marketing of his/her expertise, arrangements for personal insurance and the availability of service support. These elements can all help consultancy to combine with normal academic work; the disadvantage, of course, is that a proportion of the fee must be shared with the company and the company's rules may constrain some activities.

The strength of the exploitation company approach is undoubtedly the commercial attitude, in that it influences decisions about whether or not to invest heavily in the intellectual property area. Engaging expert advice, deciding on the defence of patents in the courts, or whether to patent ideas outside the UK, are costly matters, which are best decided by company executives, who are answerable to a board, rather than by university administrators, who may not be specialists in the area. Equally, companies wanting to do business with a university can consider an exploitation company to be an easier working partner than a university research office.

▩ European offices

For universities eligible to seek funds from the European Union, the organizational arrangements to maximize the chances of success can set special problems. These problems arise from the range of schemes available, the bureaucracy involved in putting together bids and the nature of the projects themselves. Since the EU puts special emphasis on collaborative arrangements between universities in different national systems, and often between universities and companies in several different countries, the application process is necessarily both complex and time consuming, and it demands special expertise. Negotiation with European agencies requires familiarity

with complex regulations, knowledge of the workings of the different agencies and of the time scale involved. This is not in any way written in a critical spirit, but is simple recognition of the special problems involved, that will get worse as more countries join the EU.

To be effective in obtaining European contracts, universities must employ specialist officers. They will be the eyes and ears of universities in Brussels and will assist in the drafting of applications, in the negotiations, and ensuring that the appropriate accountability and reporting arrangements are in place in the university involved. Many universities have entered consortia, to make bidding easier, and to provide ready-made lists of partners, because some of the greatest difficulties are not with the European Commission, but in reaching common understandings and shared workloads with partner institutions in other countries. Organizationally, however, universities must decide how much they should invest in such activities. They must also determine how the effectiveness of the specialist staff involved is to be measured, and how it relates to other aspects of research and to the R&D role of an institution. Bureaucratically independent European Offices often cut across other organizational units, because they are involved with European industrial relationships, intellectual property matters and complicated contracts, all of which tend to have overlaps with other parts of a university's organization.

▩ Regional offices

The importance of university-regional links is forcing consideration as to how they are best developed. The University of Sheffield's Regional Office is a good example of what has seemed to work well. The Office provides a 'one-stop shop' for access to the university by the public. It has become: "The focal point for the interactions between the University and the City and its surrounding

region, dealing with enquiries, bringing people together, developing and administering new schemes and programmes, liaising extensively and in different ways with all sectors of the community, and representing the university at functions and events" (Wedgewood and Pemberton, 1999). The Office supports various schemes, opening up links with SMEs, forming managing directors' clubs, initiating and developing business-sector networks, promoting educational access, embedding the university's research capability into the work of the regional community. It is clear that this approach has reinvigorated the relations between Sheffield University and its region, and that in an industrial city, where the traditional industrial base has greatly declined, a university with a strong research capability needs a specialist regional office that will attempt to co-ordinate its response with local and regional needs. Like the European Office, however, this function can easily create boundary disputes with other specialist offices.

The Research Office

The traditional university research office deals primarily with research grants and contracts, coming from national research bodies, research councils and foundations. Apart from the passive function of circulating essential information on competitions, closing dates etc., its prime function is administrative and financial: signing of contracts, listing, financial reporting, etc. As research has become more competitive, in positioning an institution and, in a country like the UK where the Research Assessment Exercise has an important impact on recurrent grants and on the institutions' position in a national league table, research offices have become more proactive. In the new world of university-industry-government, partnerships have begun to play a key role in helping to formulate bids, negotiating with research councils and government and ensuring that the contracts are carefully drawn up. However, these offices now tend

to sit rather uncomfortably, organizationally, when new specialist offices and agencies are springing up.

The problem of co-ordination

What has happened is that the university-industrial interface has moved from being one of many university activities, to becoming a central concern. The 'triple helix' and the 'new production of knowledge' have transformed the management of research in universities and have crossed traditional organizational and financial boundaries. Because it has become central to university success, and because so many schemes demand a significant university investment, the various specialist offices have needed both co-ordination and leadership at something like pro-vice-chancellor, vice-rector or vice-presidential levels. However, since the key players are the academics and researchers in departments and centres, this role is much less real than presentational, diplomatic or motivational. In other words, whatever the policy the university may have towards region, industry or research in general, the implementation of that policy, when it comes to the details, lies within the individual academic staff. Many of the academics will hold permanent appointments and without their support, such policies can simply remain 'stuck' at the level of aspiration. Pro-vice-chancellors may encourage and motivate, 'putting up a public face', but they cannot deliver the product. Co-ordination in this area remains a matter of debate and even, occasionally, one of controversy. At the bureaucratic level, the various offices and activities develop missions of their own, and overlaps in functions can all too easily occur. Deciding whether such offices are proactive, or a mere service rendered to providers, is again a sensitive point in many institutions. At the academic level, however, large research centres, departments and highly successful individuals tend to be successful because they follow strategies that suit their own strengths and interests. They are resistant to pressures from the centre, so

resistant that the most successful of them will be only too willing to move to another institution, in order to retain his/her freedom from dictation. At an age when universities depend increasingly on non-government support, the reconciliation of university interests with those of departments, centre and individual researchers represents a crucial element in university management.

※ Short-course units

R&D findings are increasingly conveyed to industrial as well as to other clients, through short courses, or through modular masters programmes, designed to be taken in employment. Business schools and technologically based academic departments are the most active in this area, and the networks created often result in company clubs and consortia to commission research. The provision of such programmes represents a key element in the diffusion of 'the new production of knowledge', and a very important linkage between universities and industry. These programmes will be mostly departmentally based, but universities have also created central short-course units to assist departments, either in their penetration on the field, or in the management of programmes for groups of departments or centres, which co-operatively can offer specialist programmes. Sometimes these units are located in Departments of Continuing Education/Lifelong Learning; sometimes they are linked to one of the offices described above. Although, in this paper, the item is placed at the end of the list, their existence is important, particularly in locations where knowledge-based companies are replacing traditional industry, or where industry is undergoing a modernization of programmes. In such circumstances, short-course programmes represent powerful tools for bringing universities and industry together.

Financial issues

It needs to be remembered that one of the stimuli for universities to expand their role in these new markets, is the pressure that is placed on them by the increasing reduction in the resourcing of university teaching. However, the more universities follow this route, as a way of generating new income, the more at risk they place themselves, as they move away from the comfort of being funded by the state against student number targets. Large research portfolios are not necessarily financially beneficial, and can often be a considerable drain on a university's resources, unless overheads or indirect costs are claimed at an appropriate level. Research funded by powerful medical charities, like the cancer research campaign, which offer no overhead to a university, are in effect obtaining a subsidy from the university itself. The more a university enters the large research leagues, the firmer its financial control must be, and the more closely its research office must ensure that the terms of the research contracts are being fulfilled. Failure to do so can lead to significant losses of income.

Overheads/Indirect costs

The question of the level of overheads, or to use the preferred phrase, 'indirect costs', that should be charged in respect of externally financed research, is often controversial. Nothing, however, can be as potentially controversial as the manner in which, once obtained, they should be divided between the centre of the university, in respect to central costs, and the department or research centre. There are, however, some principles which should be observed:

(a) A university should not subsidize private industry by undertaking contract research and failing to charge an appropriately calculated indirect cost rate. Industry will often

argue that it is paying its taxes and should therefore not be expected to pay a university's running costs twice. However, as we all know, it is not paying twice, because a university is not funded for the additional running costs that taking on contract research imposes. Also, the market demands that costs be covered – this is no more than what a private company would do, undertaking contract research for another company.

(b) The charge should be transparent, i.e. its make-up should be described in sufficient detail so that the company may understand what it is paying for. Warwick, for example, seeks a 105 per cent overhead on research in science and technology, and 65 per cent in the social sciences. These charges are based on a formula that covers the number of staff involved, the space occupied and the overall demands placed on the university by the contract. For research grants from research councils, a university in the UK receives an overhead of 46 per cent, but this is on the understanding that a university receives a level of support, from its government recurrent grant, for basic research through the 'dual support' system.

(c) Since the individual researcher normally undertakes the immediate negotiation with the sponsor, it is important that he or she is adequately briefed on the scale of charges. Also, final authority for the acceptance of the contract and the overheads involved is vested in the Finance Officer, or in some other senior officer, who is able to refuse to sign if the figure is not reached. A university should feel able to 'walk away' from a research contract that does not match up to covering its costs. The individual academic is, only too often, more interested in the contract, for the research involved (or occasionally the individual consultancy that goes with it), than on the level of

overhead charged by the institution. Reconciliation between the respective interests of the researcher and the university has to take place.

(d) An element of the indirect costs must be incurred at departmental or research-centre level and the sub-division of the lump sum needs to be regulated and transparent. What happens to the departmental share, is a matter the department must deal with, but there are often internal disincentives, where the department takes the entire departmental share and does not disburse an element to the individual academic's own laboratory or office. Some universities, including Warwick, operate a sliding scale as an incentive to secure the full indirect cost, so that if a contract brings in the full 105 per cent, the department receives a higher proportion of the overhead than if it only brings in 40 per cent.

(e) There is no substitute for transparency at all levels, but experience suggests that while this may make the resolution of difficulty easier, nothing will eliminate the possibility of dispute.

Incentives and motivation

While academic life and research, in particular, depend a great deal on personal motivation, there is no doubt that, in the real world, rewards are important. The most effective rewards are not necessarily financial; public recognition of achievement, granted by the university authorities, as well as by one's peers is sufficient. Nevertheless, well-managed staff promotion procedures that reward success in research are important stimuli to good and sustained performance, just as poorly managed or arbitrary procedures or procedures that seem to prefer age and seniority, to talent and success, are important demotivators.

Resource allocation, whether at the level of university to department/research centre, or department/research centre to the individual, provides a crucial reward system. In a department that outperforms the rest in research, but receives the same formulaic allocation of resources, based only on the number of students, teachers will rightly feel that their institution is expending its efforts in the wrong way. An individual academic who is winning large contracts, but who is given a norm-based space allocation, or a norm-based allocation of secretarial or other departmental support, will feel similarly 'demotivated'.

A university culture that consistently rewards success is difficult to build up and to sustain but, once achieved, it provides the leverage which encourages individuals, departments and the institution as a whole to over-perform, in comparison with other universities.

▩ Investment

Research is expensive in time, equipment and salaries. In the present highly competitive university world, universities need to build up reserves that can be invested into research areas that match the new research economy. This implies the need to develop a strategic view of research and not simply a reliance on the research interests of individual academics. It is for this, among many reasons, that universities have tended to designate a vice-rector or pro-vice-chancellor to take the lead, both in overseeing research offices and other organizational units, and in trying to develop a coherent institutional research strategy. Within the fast-moving competitive research market, and in the world of research partnerships and alliances, an essential feature of the 'new production of knowledge', it is essential that a university, at very short notice, is able to make quick decisions and have available funds for effective investment, or for the mobilization of research teams, or facilities. Universities need

to be more business-like if they are going to play their full part in the knowledge-based economy.

Conclusion

What the foregoing suggests, is that the traditional organization of universities round disciplines, and the traditional university financial structures, need significant adaptation in order to fit in the new environment. Some universities favour significant financial or managerial devolution, as compared to department/research centres, but this can strip the institution of its overall strategic role. On the other hand, managing a university like a command economy will certainly stifle the entrepreneurial spirit, at the level of the academic unit. A plethora of single-function offices for European contracts, or for regional activity, can breed bureaucracy, but bundling all these functions into one Research Office can reduce the focus on individual lines of activity. Individual universities have to find their own solutions to these problems, depending on their size, disciplinary base and the economy of their region. However, what has become clear is that either the implications of the new industrial environment must become a central element in a university's business, or it will pass it by. If universities allow themselves to be bypassed, they will seem increasingly irrelevant to society, and will lose their best staff, either to competitor universities or to non-university-based research and training consortia. The development of knowledge-based industries, and the economy as a whole, would also undoubtedly suffer.

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References

Etzkowitz, H. ; Kenelgor, C. 1998. "The role of research centres in the collectivisation of science". In: *Minerva*. Vol. XXXVI. No.3; Autumn: 1998.

Etzkowitz, H.; Leydesdorff, L. 1998. "The endless transition: a 'Triple Helix' of university-industry-government relations". In: *Minerva*. Volume XXXVI. No.3; Autumn:1998.

Etzkowitz, H.; Webster, A. 1998. "Entrepreneurial science: the second academic revolution". In: *Capitalizing Knowledge* (Etzkowitz, H.; Webster, A.; Healey, P. (ed). Albany: SUNY Press.

Gibbons, M.; Limoges, C.; Nowotny, H.; Schwartzman, S.; Scott, P.; Trow, M. 1994. *The New Production of Knowledge*. Sage.

Goddard, J. 1999. "How universities can thrive locally in a global market". In: *Universities and Wealth Creation*. Gray, H. (ed). Open University Press.

Kantor, R.M. 1995. *World class: thriving locally in the global economy.* New York: Simon and Schuster.

Lundvall, B.A.; Johnson, B. 1994. "The learning economy". In: *Journal of Industry. Studies* 2.

Shattock, M.L. 1997. "University-industry research and training partnerships". In: *Industry and Higher Education.* June: 1997.

Wedgewood, M.; Pemberton, B. 1999. "The University of Sheffield's

Regional Office: Forging relationships between a traditional civic university and its regional community". In: *Universities and Wealth Creation*. Gray, H. (ed). Open University Press.

REMARKS FOLLOWING MR SHATTOCK'S PRESENTATION

by Trond Fevolden, Secretary General
Ministry of Education, Research and Church Affairs
Norway

Mr Shattock's excellent analysis of university-industry relations immediately prompted me to set up a meeting with the leadership of the University of Oslo, with a view to discussing some of the major issues. It is a good time for such a discussion. A new *White Paper* on research policy was debated in the Norwegian Parliament in the winter of 2000. Furthermore, a special government commission has just presented its recommendations for changes in our national system of universities and colleges. Both the White Paper and the commission's report focus on the relationship between universities and society at large – and thus on the fundamental issues treated by Mr Shattock. Our national debate will be helped by his analysis.

Facts and figures

I have been asked to highlight some features of the Norwegian state of the art. First of all, my country may be said to be 'too wealthy for its own good'. Public spending will necessarily be limited for fear of an over-heated economy, and private enterprise may not feel inclined to invest in the R&D needed for structural change. Total national expenditure on R&D, as a percentage of GNP, remains well below the OECD average. There are important nuances in this overall picture: despite fiscal restraint, public expenditure is substantial; it is private investment in R&D that is relatively modest, due mainly to the great number of Small and Medium-Sized Businesses (SMBs) and the importance of 'low-tech' industries. Today there is political agreement on the need to increase both public and private investment

in R&D. At the same time, structural changes in the science system are clearly called for, partly with a view to strengthening the dialogue between universities and industry. There is also renewed emphasis on quality in research and higher education.

The student 'explosion' of the late eighties and early nineties was particularly violent in Norway: the number of students enrolled in universities and colleges doubled in less than a decade. It required massive public investment in the 'science system'. Today there are about 170,000 students in institutions of higher education; 90 per cent are in public institutions and pay no fees.

Most of the funding for universities comes from the Ministry of Education, Research and Church Affairs, in the form of block grants, which cover both education and research, without further specification. For university lecturers and professors, it is understood that they spend roughly 40 per cent of their time on teaching, 40 per cent on research, and 20 per cent on administrative duties. External funding for research in universities amounts to about 30 per cent of their estimated total research funding. The major part of external funding is also public money that is channelled through the Research Council of Norway after competition on the basis of quality criteria. Industry provides about 5 per cent of research funds in universities. One reason for this modest figure lies in the importance of Norwegian research institutes, which traditionally undertake applied research and development projects for all branches of industry. As in other countries, Science Parks have sprung up near universities and a great number of special measures aiming to foster co-operation between academia and private firms have been taken. Still, we have a long way to go.

New policy directions

The aim of the government is that Norway, within a period of five years, will reach a level of research funding equivalent to the OECD average, measured as a proportion of GNP. The growth in public funding is to come partly through the yield on newly established funds for research and innovation, distributed by the Research Council of Norway. The yield will finance, to a great extent, new centres of excellence. With regard to basic funding for universities and colleges, a new funding system is being designed. The new system will distinguish between funding for research and teaching, thus making institutions less vulnerable to fluctuations in student enrolment. At the same time, it will enable institutions to refine their strategies for research. Special tax incentives for industry investing in R&D are also being considered.

The government commission referred to initially has made radical proposals for the governance of universities and colleges, which is regulated by law. Under the present system, the effectiveness of university leadership is limited by ministry regulations, on the one hand, and by bottom-up influence from (often quite conservative) professors, on the other. It is now important to ensure strong leadership within each institution, and reforms to this end may be expected. Furthermore, a special commission is actually working on proposals for amendments to statute law or regulations that may ensure better commercial exploitation of the R&D results in universities and colleges.

We have, in other words, entered a period which will strengthen Norwegian research - public and private. It will also be a period of reform, which will necessarily change universities and colleges. One

important aim will be to build additional bridges between the science system and the knowledge economy, while retaining the strength of an independent academia. The balance is a difficult one – as Mr Shattock has so eloquently taught us.

PART IV

ORGANIZATIONAL RESPONSES: THE MANAGEMENT OF INTERFACES. EXPERIENCES FROM THE HEBREW UNIVERSITY JERUSALEM, ISRAEL

by Moshe Vigdor
Vice-President and Director-General, the Hebrew University of Jerusalem

BACKGROUND

Over the past three decades, the management of university-industry relations has increasingly become a major issue within the framework of universities and on the national level, where society expects to benefit economically from research carried out within university laboratories. Relations between university and industry have not been straightforward from the very beginning. Universities seek excellence in research while industry is analyzed annually according to its profits and economic performance.

Research results, however, might develop new know-how, technology and/or products. University researchers do not aim for applied results, as they are evaluated on the basis of their publications and academic achievement through their research. As science-based industries developed, however, and as processes of research and development were established within industry, it became necessary to form a relationship between universities and industry.

During the Middle Ages the classical university strove to preserve knowledge and to pass it on by teaching it.

The Research University of the Modern Age strives to preserve knowledge, to pass it on through its teaching, and to create new knowledge. The transfer of new know-how to industry in order to transform it into new technologies and products is a new challenge.

The question posed, however, is how to bring university and industry into a dialogue that builds co-operation. The dilemma is how to create relations between university and industry that will not interfere with the internal structure of either of them. How must

these university-industry relations be managed where industry, on the one hand, is seeking fast results, and the university, according to industry, lacks a 'sense of urgency' for development. It seems that establishing an interface, in order to handle university-industry relations, is paramount for the success of these relations.

The issue has become hot and delicate during the last few years, with the vast development of hi-tech, telecommunications, computer software and the Internet, and the issue is expected to continue to hold centre stage as new models and answers in the field of biotechnology are widely explored during the twenty-first century.

The management of an interface for handling university-industry relations becomes more critical with the new trend of start-up industries. Creating a start-up industry with the help of a university professor requires careful attention, mainly because of the risk of conflicts of interest. Researchers and students are looking for opportunities to establish start-up companies based on new inventions and innovation in research.

Universities should define a policy encouraging this development. It is impossible to ignore the trend. Universities need to address the issues related to start-up companies and venture capital funds offering professors financing to conduct industrial research and to be involved in the development of new industry.

Organizational framework

The Hebrew University, since its inception 75 years ago, has been strongly involved with the needs of society and has widely contributed to the enhancement of society's welfare. The university's mission has been, and continues to be, to achieve excellence in

research and teaching, contribute to society and play the role of cultural and academic centre of the Jewish people.

In the past, the university was described by local industry as an ivory tower insufficiently involved with society and industry. Industries expected the university to act as an applied-industrial research institution, providing practical results to civilian industry 'right now'. The university carefully refused this request and did not accept this attitude. Being the largest research university in Israel, the university's emphasis is research quality. It refuses to direct its researchers regarding their topics and subjects, each professor being completely free to make his/her own choice of research.

Industry was actually quite mistaken in its perception of the additional value of university research. When a university becomes an applied research institution, it loses its added value and such a university is subject to academic derogation.

Albert Einstein, member of the first Board of Trustees of the Hebrew University and one of its founders, expressed a policy, which was adopted by the university throughout the years. He said: "Our highest ideal must be the acquisition and diffusion of knowledge. Only then can we create those permanent conditions in which practical achievements can also flourish and bring benefits to the country".

The university has seven different faculties: Mathematics and Science, Medicine, Dental Medicine, Agricultural Food and Environmental Sciences, Law, Social Sciences and Humanities. In addition to the faculties, the university also has 'schools': Engineering and Computer Sciences, Applied Science, Social Work, Pharmacy and others.

When it comes to organizational development for the management of university-industry linkages, the most common framework for university-industry management is the Licensing Office. Such an office is the information centre for new development and for patent registration to protect university researchers' innovative development. This Office is an integral part of the university and is managed in a similar manner to other administrative departments at the university. In such cases, the university is the contractual party for contracts with industry. The university controls all contractual matters very closely and directly enforces its policy and regulations.

The Licensing Office is passive, rather than active, in regard to marketing activities and in initiating contacts with industry. The very active parties are the professors themselves, seeking funding and co-operation with industry.

The Hebrew University established, in 1964, a wholly owned subsidiary called the 'Research Development Company of the Hebrew University of Jerusalem' (YISSUM) to foster relations between the university's researchers and industries.

The university empowered the company to act on its behalf in regard to any contractual matter with industry relating to the university's know-how, patents and research results. YISSUM acts as an independent and separate legal entity, providing services to the university in the area of university-industry management. The relations between YISSUM and the university are both contractual and of an ownership nature.

The company is a commercial concern and generates its own income. The contractual relations between the university and the company are based on university regulations in the area of university-industry interface. This set of regulations is binding also to university

employees. They are updated regularly by the university after consultation with YISSUM.

In taking the initiative to establish YISSUM, the university actually declared a policy statement of its interest in fostering relations with industry without affecting the academic harmony of its research and freedom.

The university is looking for new modes of co-operation with industry, but only through the interface established where academic parameters are maintained, including academic freedom and freedom of research, publication and avoiding conflicts of interest.

All business activities in regard to technology transfers, commercial transactions, and licensing arrangements with industry are handled by YISSUM.

The university is released from any legal suit or action that might be taken by an industry or investor. YISSUM is the party for such legal claims if they arise.

The interface: expectations and performance

The university established YISSUM in 1964. At that time, the university adopted a set of regulations and guidelines formalizing the relations between university and industry.

1. YISSUM's task is to foster contacts between the researcher and industry.

2. A researcher has to report immediately to YISSUM in the event that an invention arises from his research.

3. The university owns all inventions which arise from research, and any research results are university-owned.

4. YISSUM should protect university know-how and the researchers' inventions by filing patents.

5. YISSUM is empowered to enable a researcher to file a patent at his own expense, in the event that YISSUM decides not to explore the invention reported by him.

6. YISSUM is empowered by the university to act on its behalf regarding contracts with industry, licensing agreements, technology transfer, services to industry, etc.

7. YISSUM's obligations are to provide professional and efficient service and to collect payment from industry for research projects and for services rendered by the university's researchers.

8. Royalties collected by YISSUM are distributed as follows:

   - 33 per cent to the researchers (private);
   - 33 per cent to the researchers' laboratory within the university;
   - 33 per cent to YISSUM.

Twenty years later, in 1984, as relations with industry became more frequent due to growing interest in university research by multinational companies, the university updated the regulations to include more specific responses to issues of equity offered to a researcher, conflicts of interest that became relevant, consultants to industry, etc.

The new set of regulations adopted includes policy and guidance as follows:

1. YISSUM is responsible for establishing contractual relations between members of academic staff and commercial sources of funding, entering into such agreements in order to have research carried out and/or to obtain knowledge and/or receive scientific research services. Negotiations with industry or the commercial interested party will be conducted only by YISSUM.

2. Employees of the university are categorically forbidden to conduct research, divulge know-how related to their research, or supply scientific or technical services to a business concern, while using university facilities, in any other way than through YISSUM.

3. Research students who are pursuing an advanced degree may be employed in industrial R&D in any framework acceptable to the university. They are allowed to enter contractual relationships for this purpose with business concerns via YISSUM, on condition that the proposed research meets academic criteria required for the conferral of an advanced degree, as determined in conjunction with the committee of research students, and that the contractual relationship, including the submission of the research proposal, is implemented by or with the participation of the student's research adviser.

4. YISSUM is responsible for determining (by means of the researcher) whether there exist any disqualifying and/or restrictive conditions arising from previous agreements and/or contractual relations providing funding for the project, even before it is submitted as a research proposal to a business concern.

   YISSUM is entitled, at its own discretion, to veto a relationship with a business concern on the basis of the review specified.

5. The university does not permit a university employee to have an employee-employer relationship with the business concern that is financing his research.

6. A member of the academic staff may advise a business concern in the field and on the subject of the research being financed by the concern only inasmuch as this has been specifically stated in the agreement signed *via* YISSUM.

7. Ongoing activity within the university by industrial staff and/or employees and/or agents of business concerns is not permitted in general.

8. YISSUM may grant a business concern the right to 'first refusal' to apply results of research conducted under agreement. The right to first refusal shall not be granted for the exploitation of the entire scientific work of a member of the academic staff, the work and research of a research team, or a broad and general field.

9. Consultation services provided by a member of the academic staff to a business concern are a personal matter and impose no responsibility on the university and/or any of its agencies.

   As part of such consultation, a member of the academic staff may pass on general know-how relating to his academic-professional expertise to the business concern he is advising but may not pass on specific know-how that is the direct or indirect result of research that was carried out at the university and is university property.

10. As a general rule, the university does not encourage members of academic staff to hold active executive positions in business concerns and does not view such activity in a favourable light.

Special approval is required when a member of the academic staff wishes to serve in an executive capacity.

University employees, who are engaged in other activities with business concerns, should be loyal and committed to their university.

11. A member of the academic staff is allowed to hold up to 10 per cent equity position in a company which is in the area of his research, whether established by YISSUM, or without such a connection. If he/she would like to hold more than 10 per cent equity in a company, special approval is required from the President of the university.

The above regulations gave YISSUM a relevant and strong standing when negotiating with industry.

The following are the main modes of operation of YISSUM:

- research and licensing agreements;
- services to industry, which are provided by a researcher of the university through YISSUM;
- research co-operation to create new know-how and technology, whether patented or generic;
- consortia to create a new wide generic know-how;
- joint venture between YISSUM and industry/entrepreneur/venture capital fund to create a new start-up or a new enterprise based on a specific know-how/project/patent developed by a researcher or a research group at the university.

Example of research and licensing

A new molecule for the treatment of Alzheimer's disease that was developed at the School of Pharmacy was licensed to a leading European drug company. In return, YISSUM received generous research grants and royalties were agreed upon for the future. Twelve years later, the molecule became a leading drug that was approved by the United States Food and Drug Administration and its sales are expanding. YISSUM expects tens of millions of dollars will be collected in royalties.

Example of research collaboration

New tomato seeds were developed at the Faculty of Agriculture in collaboration with a local seeds company. New genetically engineered seeds were developed successfully where long shelf life was achieved. The local firm is now marketing these seeds throughout the world. The price of one kilogram of such seeds is higher than the price of one kilogram of gold.

Income of YISSUM

The income of YISSUM is continuously growing. Over the past 20 years the company has transferred to the university more than US$150 million.

Income for the year 1999 was US$16 million, whereas US$11 million was the amount of income from industry destined for research, within university laboratories, under research and licensing agreements. US$5 million was the sum due to royalties from sales of products by industrial enterprises. The annual value of products originating at the Hebrew University, sold during 1999 by industrial enterprises,

exceeded US$200 million. The average royalties received amounted to 2.5 per cent of those sales.

It is expected that this amount will triple during the next few years and that royalties will exceed US$15 to 20 million annually.

Structure of YISSUM

The President of the university nominates the Board of Directors of YISSUM. Board members include businessmen and only a few university employees. The Board elects the managing director of the company.

Internal regulations and procedures of YISSUM are like any other business entity.

Companies transfer to the university all funds received from industry for research conducted by a university researcher. It is YISSUM's responsibility to collect these funds based on former agreement.

YISSUM charges the industry 35 per cent overhead in addition to funds agreed on for continuous or complementary university research. This overhead is split as follows:

- 7.5 per cent to YISSUM to cover its operational costs;
- 27.5 per cent to the university.

The interface: dynamics

Defining the interface, its organizational structure, its tasks and charter is an important prerequisite for its efficient functioning within the university.

Building the interface as an independent entity enables it, however, to become a source for internal change of attitudes.

Basic research - its quality, its dominant position in the university, its broadness - is *condicio sine qua non* for any applied research.

A university should not establish its relations with industry from a point where applied research is perceived to be more profitable or more important than basic research. Applied research is the outcome of basic research and it is important to maintain this path.

However, the interface and its successful ventures with industry should provide a positive spirit towards co-operation with industry, including researchers whose research topics are mainly basic. The interface should also be involved in exhibitions demonstrating achievements in applied research, both to the internal university community and to industry, venture capital funds and investors. Such exhibitions create an atmosphere for greater co-operation between university and industry and, when made on campus, will also influence students, enhancing their comprehension of interaction between industry and university. This atmosphere of co-operation adds a motive of competition on campus and fosters more inventiveness and creativity both in applied and basic research.

An appropriate and balanced atmosphere, encouraging further relations between industry and university, leads to the creation of a dynamic environment to create and establish courses with industry or of industrial orientation.

Example

During the past two years, the Hebrew University has introduced new courses concerning industry to the regular curriculum.

The best to industry

Masters degree students in chemistry, biology, physics, and mathematics were introduced to appropriate science-based industries, choosing a project to work on in co-operation with industry and under the approval of the academic authorities. This is a whole-year project that is part of the student's obligations in completing his required curriculum.

The benefits are enormous.

1. University and industry open a dialogue and seek ways to co-operate.

2. Students become familiar with industry and its needs.

3. Industry might gain immediate benefit from the project carried out by the student.

4. Students are proud to work on a prestigious programme, to which only the best may apply.

5. Students receive a special scholarship from the industry.

6. It is expected to lead to the integration of some of the students, just as in the case of new employees, into the specific industry, bringing with him/her relevant knowledge and understanding.

Steps in entrepreneurship in the Internet

For those courses involving co-operation between the university and start-up groups, the students (divided into teams of five: two from the School of Business Administration and three from the School of Engineering and Computer Sciences) work on new ideas for the Internet.

New start-ups are already under way from these groups. Teachers of this course are from both university and industry, creating, therefore, unique co-operation between the two establishments.

The above description is resultant to a dynamic process, developing at the university and arising from the understanding that co-operation between university and industry is both important and possible. This development leads to a decision to create a special site, within the campus, to host new start-ups. An area designated for start-up industries within the campus will add to the atmosphere of co-operation, thus ensuring that such co-operation will be carried on in accordance with university regulations and policy.

Summary

The management of the interface for university-industry relations at the Hebrew University of Jerusalem derived from the university policy.

When a university seeks to develop co-operation with industry, a set of regulations should be prepared and a decision taken regarding the type and nature of the interface and the relations it should maintain with the university. Much is dependent on the expectations from the interface and from the co-operation with industry.

The tasks of a university are research and teaching. The university should not directly conduct business, nor directly run economic enterprises.

The idea to create a cluster of companies, promoting the economic interests of the university, without detracting from its main tasks, seems both reasonable and appropriate.

A company, wholly owned by and empowered *inter alia* to act on behalf of the university concerning the management of university-industry relations, was found to be appropriate at the Hebrew University for exploring university potential and intellectual property towards business opportunities with industry and commercial concerns. The issues of possible conflict of interest and publication are being dealt with in an efficient and delicate manner by the company, based on regulations established by the university.

Where the interface between university and industry is not sufficiently clear, issues of conflict of interest will arise, immediately threatening the university's internal structure.

YISSUM has become a leading factor within the Hebrew University due to the fact that the policy of the university is clear, that YISSUM does not interfere with the academia, and that there are sufficient incentives and remuneration to assure researchers that their work will lead to a viable product.

YISSUM is engaged in marketing activities, including initiation of know-how fairs, and aims to 'catch' opportunities with resources.

In order to provide YISSUM with better tools, there is a need to establish a venture capital for it. The university did establish a fund of several million US dollars to be used as seed money for new ideas, as well as a better price for licensing to industry, but it seems, however, that this sum is insufficient.

The issue of involvement in start-ups and in venture capital funds has become important in recent years. Researchers and students are looking for opportunities to establish start-up companies based on new inventions and research innovations. The university, together with YISSUM, is working on a method and mechanism to equip it, under current regulations, with the needed adaptations.

New regulations will induce change in the nature of the interface between the Hebrew University, hi-tech companies and the start-up industry, mainly in the areas of computers, software and the Internet. We are entering a new area in the management of interface, developing and enhancing further relations between the university, its researchers and new-economy industries.

The university is engaged in initiating and constructing a new site to host start-up industries, with preference given to those which originated from the university's laboratories. This should further boost the relations between the university and industry, where continuous change and original thinking are needed.

IN RESPONSE TO MOSHE VIGDOR'S PAPER

by Knud Larsen, Danish Ministry of Research

I would like to make two general observations regarding Moshe Vigdor's paper on YISSUM, the interface for the management of university-industry linkages at the Hebrew University of Jerusalem.

- A general and international market for R&D is developing very quickly. It involves growing competition, as well as a trend towards commercialization. Universities are at times acting as if they were enterprises.

- Information technologies should be seen as an important tool in developing relations between university and industry. We have seen only the beginning to a worldwide communication system in which the barrier between public and private - or between university departments and industrial laboratories - disappears.

There are, however, a number of points for discussion.

1. The university-industry interfaces have changed fundamentally during recent decades since information technologies or biotechnologies have become core subjects in curricula and on research agendas. It means that *technologies* have crossed the borderline between the research area and industrial environment. Some examples of these would be nano-technologies, micro-technologies, etc.

2. An impact of this development is that researchers deal with technologies and, accordingly, industrialists with research.

3. It is important to remember this relation, especially because it means that the management of interfaces is no longer an academic

matter, but an essential part of daily life in the university as well as in industry. The relations between the two parties have developed into a lasting relationship of interdependence.

4. The organizational response to this development has several facets and we have tried to develop some of these into practical solutions within a Danish context. Three examples are the following.

   (i) The *first* example is about an in-process-transformation of the Danish Technical University. The main components in the transformation are:
   - from state-owned to self-governing institutions;
   - creation of a board of governors with full responsibility for running and developing the university;
   - built-in facilities for small innovative firms with strong appeal to students as an example of applied outcome of basic research.

The Danish Government intends to use this platform to forward a more or less complete interaction between industry and university. What will be the cost? Certainly not a decrease in basic research or in fundamental education. On the contrary, the incentive will be - hopefully - strong and create a very direct stimulus to promote and even sharpen classical virtues of universities, because that is what is demanded by industry.

   (ii) The *next* example is on a merger of institutions. Two cases are to be noted.
   - We have formed, in the Copenhagen area, an amalgamation of biotech-competences from four universities in a type of joint property, also open to participation from private firms. On the very same site, we are building facilities for a research park as an integrated part of the merger.

- A bridge has been built connecting the Copenhagen area to the southern part of Sweden. It means a very interesting linkage between two ancient university towns: Copenhagen in Denmark and Lund in Sweden. For some years we have, on a bilateral basis, worked on the formation of a so-called *Oresund University*. This is not an example of a real merger of institutions, but the idea is simply to take advantage of *synergy* from the doubling of competences and qualifications. It is based on a close co-operation between industry and universities. The best visible example so far is the creation of *Medicon Valley* - the name for a formalized co-operation of universities and a variety of pharmaceutical firms on both sides of the *Oresund*.

(ii) The *last* example is the creation of an IT-university - once again in the Copenhagen area. It could be considered to be a reaction to the slowness of older universities in their response to industrial needs and demands for qualified students within information technology. In what has proved to be, to this day, a successful construction, based on a deal with the older universities, the IT-university has developed a broad and very attractive package of educational elements in a seamless dialogue with industry. Once again, barriers between highbrow university intelligentsia and down-to-earth industrialists are as artificial as the often-mentioned, but non-existent, ivory tower.

This discussion leads me to the following conclusion.

The three examples mentioned above have been given to illustrate one simple observation. The very convincing model developed in Israel, presented so brilliantly by Moshe Vigdor, is not the only possible way to proceed when your ambition is to stimulate linkages

between higher education institutions and industry. It can be modified and will be so when experiences from all over the world are compared. It is of extreme importance, however, to have a full and free exchange of information on courses taken and experiences gained, because the market *is* developing very fast!

PART V
INTELLECTUAL PROPERTY RIGHTS AND RULES ON CONFLICT OF INTEREST. EXPERIENCES FROM UNIVERSITY COLLEGE LONDON

by Jeffrey Skinner
Director, UCL Ventures, University College London

THE PROBLEM

Universities are placing increasing emphasis on active management and exploitation of intellectual property (IP). This is a relatively new 'line of business' for them, and though rightly still a distant third to teaching and research, the importance now placed on this activity is reflected in the investment many universities make in patent protection and their maintaining a professionally-staffed Technology Transfer Office (TTO). This cost can easily top £1million a year for a major research-led university.

There are a number of possible reasons for the emergence of Technology Transfer (TT)[1] as a major activity in universities.

1. The need to be seen active in transferring technology into economy - to somehow justify public or charitable researches expenditure.

2. To attract the best staff by giving them necessary support and freedom to become involved in the commercial development of their research and in reaping rewards from it.

3. The hope that the university may reap substantial financial rewards from a major licence deal or sale of equity in a spin-off company.

4. The realization that professional IP management is fast becoming the cost of doing business and that mistakes - for example committing the same IP to two different collaborators - can expose the university to liabilities.

There is no doubt that universities like to have the *reputation* of being the source of important new products and services. Such stories are highly newsworthy and enhance political and public perception, attracting the best students and staff to the university. However, the cost of running a Technology Transfer Office (TTO) is now so high that, in the author's experience, most TT Offices quickly need to become self-sustaining, at the very least, and many (including University College London, the author's own institution) have an explicit *profit* motive and must justify their own existence and growth in financial terms.

However, it is also true that universities may no longer *ignore* Intellectual Property (IP) issues. Ownership of IP Rights (IPR) has become a major negotiating issue in contracts with research collaborators and sponsors. There are two structural changes driving such change.

- Universities are seeking funding from a multiplicity of public and private sources and are increasingly encouraged to collaborate with each other.

- Organizations in public, private (and even charitable) sectors have become aware of the commercial importance of IP rights. Industrial sponsors now realize that universities may take a robust position towards IP and seek greater clarity over ownership of IPRs. Charities fear potential embarrassment due to the university taking, running and exploiting an invention without receiving anything in return. Universities (on the other hand) are afraid of inadvertently 'double selling' the same IP to two sponsors.

1. Technology Transfer is used in this paper to describe licensing and spin-off activities. Such activities are but a sub-set of *knowledge transfer* which encompasses a much wider set of activities including student training, research contracts and academic publications.

Intellectual property policy

IP management is a relatively recent addition to the portfolio of university activity. Consequently, policy relating to technology exploitation, and in particular spin-off companies, is much less developed than within traditional areas of teaching and research. Moreover, most senior faculty are promoted to senior management positions on the basis of their teaching and research excellence. Consequently, few are able to exercise sound and balanced judgement when it comes to technology exploitation issues. Lack of policy and experience can lead to over-cautious behaviour (when the void is recognized) or to cavalier or reckless behaviour (when it is not). Either extreme is unhelpful and can become a serious long-term impediment to effective exploitation of the university's IP base.

Very difficult policy issues relate to faculty involvement in spin-off companies – companies based on university IP in which faculty, university and outside investors take equity. Few commercial companies would countenance giving their employees the freedom to take an executive role in a separate – possibly competing – business while maintaining their present job. The conflict of interest and 'dilution of loyalty' issues would be impossible to police or tolerate. Yet universities are increasingly *encouraging* faculty to consider involvement and equity in such spin-offs. In doing so we, as policy-makers, have somehow to find ways of limiting conflicts and liabilities that inevitably result.

Managing and exploiting IP provokes a multitude of new policy and management issues. The following are examples:

- what rights should a university exercise over IP generated by faculty – should universities exercise rights or waive them in favour of the inventors?

- should faculty be allowed to hold equity in a spin-off company, and if so should they be allowed to consult for the company, act as principal investigator in a contract research between the company and the university, or act as technical director of the company?

- should the university seek the right to appoint a director to the Board of a spin-off?

- should faculty be allowed to take equity in a spin-off developed by one of their research students?

- is it preferable for the university to take an equity stake in a company, or license technology in consideration of a royalty?

- should the university give warranties to a spin-off or commit a future 'IP pipeline' to the company in order to make a deal or secure greater equity rights?

- should the Technology Transfer Office be treated as any other administrative department within the university - essentially a cost centre - or should it function as a profit centre, competing with industry for the best business development staff and considering profit-related pay?

- should the university force a member of faculty to patent a new commercially valuable invention when the scientist involved would rather freely disseminate his/her work?

The fundamental issue facing the policy-maker is largely, in the author's opinion, the same in each case. On the one hand, senior managers in universities wish to encourage and stimulate entrepreneurial activity and fervour - both amongst faculty and Technology Transfer professionals. On the other hand, they are afraid of somehow destabilizing the university for the following reasons:

- a 'dilution of loyalty' of faculty – allowing faculty to put themselves in a position where they face, *or could stand accused of having their judgement affected by,* conflicts of interest;

- the risk of a substantial reputational or financial loss if something goes wrong;

- treating the TTO as a commercial unit, with commercial targets and staffed by the best professional TT managers on higher salary levels – which may create resentment amongst equally dedicated but lower-paid administrative staff employed elsewhere by the university.

There are of course 'zero option' policies that are open to universities that wish to play safe. Some USA universities – notably in the Boston area and Silicon Valley – have addressed the issues by instituting strict policies that all but prevent any potentially damaging issues arising in the first place. For example:

- Faculty are permitted to hold equity, but if they do they are not permitted to undertake any related research in their university laboratories.

- Faculty refuse to enter into any pipeline IP arrangements with companies.

- Technology Transfer Offices have a remit to seek out patent and to market potentially valuable IP – however, they go no further than licensing the IP (in its existing state) to companies. They do not appreciate helping faculty form or raise investment for new ventures.

The Boston and Silicon Valley cases are exceptional, however, in that existing firms in the area are hungry for new technology; these

regions (clusters) are extraordinarily fertile 'spin-off factories'. As a result, universities need do little more than administer and regulate exploitation activity. Few other parts of the globe are similarly blessed. Though we may (and many of us do) aspire to creating a similar environment in which the local economy is so hungry for our technology that it hands us ready-made licensing propositions, the same policies applied almost anywhere else – though maintaining purity – would snuff out any entrepreneurial or start-up activity.

Nevertheless, many universities in the UK – and elsewhere – are discovering a middle way. They begin to adopt and institute, in the light of experience, sensible IP and spin-off policies and practices giving sufficient freedom, yet preventing, at the same time, the worst excesses and potentially catastrophic financial or reputational losses. Many now expand their Technology Transfer operations, both in terms of size and scope, introducing their own seed funds for early-stage investment in spin-offs and stimulating forums to permit faculty entrepreneurs and investors to meet and do business.

This paper attempts to tease out some of the more important IP policy issues by describing the evolution of Technology Transfer at the author's own institution, University College London (UCL). When UCL established its first Technology Transfer Office, a decade ago, it had little experience and virtually no policy specifically relating to the management or exploitation of IP. It has now established a number of working practices and guidelines which, like most good rules, have evolved gradually in the light of experience and experiments.

The experience of UCL Ventures

UCL Ventures (UCLv) is the Technology Transfer arm of University College London. Over the course of a decade it has:

- filed over 200 patent applications and negotiated around 80 Licence Agreements;

- helped UCL spin-offs to raise approximately £30 million investment capital for the creation of over 30 spin-off companies.

It is, in addition, responsible for raising IP awareness within UCL and for administering Material Transfer, Non-Disclosure and other IP-related agreements between the university and third parties. UCLv has a staff of seven Technology Transfer professionals and an annual patent/legal budget of around £350 000. A large majority of patents, licences and spin-offs, in which UCLv has invested, have *not* borne fruit. A small number, however, have done exceptionally well, bringing in around £20 million in licence income and sale of equity.

The beginning of technology licensing at UCL

Technologies patenting and licensing activity pre-date the formation of the Technology Licensing Office in 1989. Before that time, a number of faculty had seen the value in taking out patents, and though lacking any interested central unit within the university, found and instructed patent agents themselves, meeting the costs through departmental funds. When companies began to take an interest in these patents, UCL took the decision to appoint its first Technology Licensing Manager, both to negotiate with licensees and to stimulate more patenting and licensing activity within the university. The new Technology Licensing Office was structured as part of the Research Contracts Office of the university – which itself was structured as a wholly owned subsidiary company of the university (UCLi Ltd) with its own Board of Directors which reported to UCL's Finance Committee.

(i) Existing policy

Despite the lack of patenting activity before 1989, there were nevertheless a number of general policies in place.

- All IP generated by faculty belonged to UCL – which was already the default position by law. UCL, however, waived this right in respect of scholarly works (books). Most other universities adopt similar policies.[2]

- Like other universities, UCL operated a revenue-sharing scheme with inventors whereby they received a share of royalties (after costs) ranging between 70 per cent (for royalty income below £50 000) and 45 per cent (for income above £250 000).

- General 'conflicts of interest' policies prevented faculties from initiating business (e.g. research contracts) from any company in which they had a material interest.

The new Technology Licensing Office (TLO) negotiated the first licences and it is significant that they produced quite sizeable (£500 000+) royalty income within only a few years. This early income enabled the TLO to be self-supporting and immediately engendered belief amongst senior managers that Technology Licensing was a profitable activity. Many a TLO office has found that its university's attitude to Technology Transfer following a major licensing success has changed dramatically.

Over the next few years the TLO grew into two licensing professionals. The office attempted to expand; however UCLi Ltd was, as a whole, under pressure for short-term income to UCL and, as a result, the Board always felt constrained to increase the headcount.

(ii) Patent expenditure accounting

An issue that troubled UCL in the mid-nineties, related to the treatment of patent expenditures and other 'project' costs (e.g. legal). Patent costs were, from the beginning, treated differently from much other expenditure. They were placed in long-term 'suspense accounts', with the expectation that most of these accounts would eventually be reimbursed by royalty income.

However, this treatment resulted in the accounts being overlooked for several annual audits and it was not until the mid-nineties that the level of expenditure was realized - by which time the cumulative deficit on project codes was well in excess of £1million. On investigation it was found that many of the projects had little hope of generating revenues and UCL had to take a very substantial write-off.

It is of course extremely difficult to 'pick winners', and as a general 'rule of thumb', only one in five patents ever pay back their costs. However, major costs of maintaining a patent occur two years after the original filing, by which time it should be clear whether a patented technology has commercial potential. During the early years of the TLO, patents tended to be renewed and maintained, past the two-year hurdle, almost as a matter of course.

Some universities have experimented with 'patent committees' - i.e. panels evaluating the commercial value of patents before deciding to go on with them. To the author's knowledge, such panels have generally not worked well since only the Technology Licensing Officer has sufficient information for making the decision.

2. The distinction is not as clear cut as it used to be given the current interest in distance learning over the Internet. Teaching materials written by faculty may have substantial value in the future.

Furthermore, while they should be asked to justify their decision to proceed, their judgement is usually accepted at the *application* stage. *Two years on*, however, there must be a very strong case for proceeding an application for patent and universities generally do not do so unless they are very confident in licensing a technology.

Having said this, it is interesting to note that the greatest revenue earners at UCL have been technologies that were unlicensed until well *after* their second anniversary. By the time they were licensed, they had racked up six-figure project budgets!

Early spin-off activity – the birth of UCL ventures

In early 1990, a number of faculty approached the finance division at UCL seeking help to form new ventures (spin-off companies) based on their research findings. These groups could have chosen to license their technology, but instead wanted to become, themselves, the driving force for the commercial development of their project. UCL realized that it had no mechanism for assisting faculty in their aspiration, but at the same time Derek Roberts, the Provost, decided that this activity was a good idea and should be encouraged. He decided to install a structure giving commercial guidance and provision for early-stage funds to faculty-driven spin-offs.

At that time, UCL's bankers were keen to invest in early-stage technology ventures and, with their help, UCL created a 50-50 joint venture – UCL Ventures Ltd – as a vehicle for investing in spin-offs. The bank provided seed finance and UCL appointed a 'Venture Development Manager' with business experience to work with faculty, advising on business planning and providing mentoring. The new Joint Venture Company had its own Board, comprising both sophisticated investors and others with experience in start-up companies.

In the event, UCL Ventures Ltd only made one investment before the Bank changed its priorities and its funds dried up – UCL Ventures Ltd (the limited company) became dormant. The one-man unit within UCL, however, which adopted the name of UCL Ventures (UCLv) continued to work with faculty entrepreneurs. Over the course of six years, approximately twelve companies were spun-off of UCL, the main source of investment being a government-run scheme to support new technology-based companies (SMART[3]).

It is significant that, in these early days, a Board monitored the UCLv activities, even though it had little UCL representation, apart from the Provost. This allowed running UCLv as a commercial operation, separate from the established academic committee and departmental management infrastructure that monitored and advised most other aspects of UCL. It is also significant that the head of UCLv reported directly to the Provost on a day-to-day basis, and was thus able to circumvent the normal decision-making processes of UCL by legitimately going straight to the top. This direct access was essential given the urgency, risk and unusual nature of decisions that often had to be made with respect to spin-off companies (for example, when UCL had to step in as a lender of last resort). It is true that without constant support and derived authority from the very top, UCL Ventures could not have survived.

UCLv considered over 150 proposals over the course of six years – of the dozen that were financed, less than half have proved to be successful. However the experience of encouraging spin-off activity was nevertheless extremely valuable, since it allowed UCL to learn – sometimes from its mistakes – how to manage and relate to spin-off companies within its midst. A number of protocols or 'rules of thumb' emerged.

(i) Use of UCL resources by academic-run spin-offs

Faculty often desired to base their spin-off within UCL – usually operating from within their own UCL laboratories. They had no formal mechanism, to begin with, for handling such requests; no one, however, wanted to prevent such use (since it seemed to do no harm) and so it happened, but without a formal agreement (and without charge). Unhappy with these casual arrangements, various administrative units in UCL (e.g. Estates, Research Contracts) developed – with UCLv's help – template contracts for spin-offs, which were used for all subsequent spin-offs, in a relatively painless and efficient way. The principle was quickly established whereby spin-offs paid (albeit at below-market rates) for all resources being used at UCL. Indeed, every aspect of a spin-off company's relationship with the College is now defined by a separate legal agreement.[4]

At the same time, UCL now considers it unhealthy for spin-offs to remain 'on campus' for more than two years. As long as they remain in an academic setting, it is very difficult for companies to shrug off academic culture in favour of a more commercial outlook. Worse, when a commercial manager does join the company, he tends to become institutionalized.[5]

(ii) Conflicts of interest

The conflict-of-interest issue was described in a memo sent to the Provost in 1994, which is worth quoting here:

> ***"In most matters relating to College business, senior faculty can be trusted to act in a way that is largely in the interests of UCL. This is not surprising given that the rules, incentive mechanisms and***

3. The Small Merit Award for Research and Technology – a much applauded government scheme for small companies. Under the scheme a small company can apply for a £45 000 grant to develop a new product.

culture of the College have evolved over a long period to reinforce excellence in teaching and research. Academics may appear to act selfishly at times but this private self-interest generally leads to good for the institution. The result is that the Senior Management in College can macro-manage the 'economy' and spend their time on exceptions and new initiatives.

However, when researchers start their own businesses a whole new dynamic is added to a system that is otherwise in equilibrium. Academics [faculty] face a number of conflicts of interest, some of which they may not even recognize.

- *If they spend too much time on their businesses, UCL is deprived of their time and intellectual energy. This drain may not become apparent for many months, even years.*
- *Students may be used for company business and feel vulnerable if they refuse.*
- *Technology can be 'pipelined' from the Department to a spin-off company in which the academic has a commercial (equity) interest.*

The result is that UCL should no longer rely upon the academic to make the right choices – it needs to micromanage that academic's activities or create a situation in which the conflicts cannot occur."

UCL's response to this could have been to ban all interactions between itself and any spin-off in which a member of faculty had an interest. However, this 'zero option' would have snuffed out all such activity. It decided instead that the best way to manage these

4. For example, use of premises, equipment, research contracts, consultancy (including work that the founder does for a spin-off) and IP past and future.
5. The author knows of one case where, after six weeks in the company, a salesman started imitating faculty by speaking at conferences on how to be a salesman in a high-technology company.

situations was to ensure that another member of UCL had sufficient knowledge of the activities of the spin-off to spot any conflicts before they became serious. In addition, faculty were required to keep their Head of Department (HoD) informed of the spin-off's activities. This was difficult, however, when – as was so often the case – the faculty member was also the HoD. So UCLv (on behalf of UCL) began to take a seat on the Board of spin-off companies and remained on the Board for as long as the relationship between the company and UCL remained 'complex'. This was considered to be the case where the spin-off had a research contract, consultancy or directorship with the company – or where the company occupied the academic's own laboratory. Faculty rarely resisted this, since the UCLv Director also added great value to the spin-off. Indeed, often the only two people driving a business in the early stage were members of faculty and UCLv.[6]

(iii) UCL's equity interest in spin-offs

Very few universities were actively encouraging spin-offs at that time. Some that were (for example, Leeds and Manchester) took a very hands-on approach to creating and managing spin-off companies, sometimes employing their own managers to develop and grow businesses, personally owning a very large percentage of the equity (sometimes 100 per cent).

UCLv took an entirely opposite approach. Its role centred on facilitation and advising rather than on driving and controlling. Once faculty became aware of their new-found freedom to set up spin-off companies on site, they began contacting UCLv. What they expected from UCLv differed widely – some simply wanted to know 'the rules' and then to be left alone (which was fine); others took the notion that UCLv should somehow take their idea, exploit it and simply pay the originator a sizeable royalty!

In practice UCLv evolved in a way somewhere in between. UCLv was most valued by faculty as a sounding board both for ideas and for its network of advisers. A guiding principle came to be that it was always *faculty* that drove the ventures. The founding scientists remained in control of the venture, which thrived or died, depending on the team's enthusiasm and commitment. UCLv never wrote a business plan or made a presentation to an investor. It never adopted the role of MD in the company or made decisions on any matter of strategy. However, its members spent hundreds of hours talking and bouncing ideas around with faculty and they brutally reviewed dozens of business plans and presentations. Faculty came to realize that very few people within their own department were at all interested in their new venture – if they wanted to talk through their commercial ideas then they came to UCLv, where they always received an enthusiastic hearing.

UCLv staff also realized, from a very early stage, that in the land of the blind the one-eyed man is king and that their own expertise in any one industry or technology was too shallow to qualify them as experts. Consequently, UCLv never felt sufficiently informed for scotching an idea, but did feel responsible in finding an expert who could. From the outset of any putative venture, UCLv challenged faculty to seek out the best advisers for commenting and advising on business propositions and shaping the strategy. It always accompanied faculty on such visits in order to act as facilitator (ensuring that the expert was never too polite about a bad idea), and increasing its personal list of useful contacts. To this day UCLv's most important asset is its network of experts who are happy to give 'quick and dirty' appraisals of technology-based products and businesses.

6. It goes without saying that no member of the Technology Transfer office or UCLv was allowed to take an equity stake in any spin-off.

Because of its 'back seat' role and its desire to keep founding scientists incentivized and in control, UCLv never sought a majority role in a spin-off, but would more usually ask for between 10 to 50 per cent, dependent on the following elements.

- Strength of the IP portfolio (usually patents or software) being licensed to the new venture. (Indeed, where only know-how was involved a figure of between 5 to 10 per cent might be reasonable, the rest being split among the faculty team).

- Whether in addition a conventional royalty was agreed to being part of the licensing agreement with the spin-off.[7] Faculty sometimes favoured UCL taking a near-commercial rate royalty in minimal equity so that they could retain a controlling interest in the company. UCL preferred to take a mixture of royalty and sales in order to minimize the following risks.

  - Spin-offs developing a new technology, based on the original ideas, and some-how circumventing any patents (and therefore royalties). Equity participation mitigated this risk.
  - UCL being diluted through successive rounds of financing – a royalty on sales provided an effective barrier against such dilution.

Conclusion

None of these emergent practices became formal policy, but rather working practices – essentially the way in which UCLv 'did business'. Spin-offs created during the first few years of UCLv were valuable learning experiences for it. Few of the ventures have yet lived up to their ambitions or returned substantial sums to UCL and, in looking back, some of the ventures should have been discouraged at the outset, or financed and managed in an entirely different way, with much more emphasis on early external participation. Lessons learned,

however, along with the foundation, set forth more ambitious ventures that were still to follow.

UCLv matures

Three significant events occurred in 1996/97 that were to shape the future of Technology Transfer at UCLv.

(i) Stanford Rooke Ltd

One of the first UCL spin-off companies floated on the stock exchange, Stanford Rooke Ltd (SRL – named after Professors Stanford and Rooke) had been incorporated in the closing days of 1992. The scientific team had discovered new myco-bacteria that appeared to be extremely effective at curing TB, with a number of other important indications – all of which applications had been patented by UCL. After a couple of abortive licensing attempts, Stanford and Rooke decided – with the help of a personal friend experienced in corporate investment – to set up a new company developing the technology. UCLv negotiated a 15 per cent holding in the company. SRL floated in 1995 and UCL was able to sell its shares a year later (for which it eventually received over £7 million).

This event transformed UCL's attitude towards new ventures. Until then, few had really believed significant sums could result from spin-offs, and those that did believe, could not visualize the mechanism. Yet the College earned sufficient support, through a single venture, for the entire Licensing and Ventures operation for 15 years (even though the money, of course, was rightly used for urgent capital projects). The sale and its proceeds transformed hearts and minds.

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7. Both MIT and Stanford had a policy of seeking near-commercial royalty rates but waiving up-front fees (which the spin-off could not afford) in favour of a minimal equity stake (2-3 per cent undiluted through the first round of funding).

(ii) Hoeft Rademacher Ltd

Most new ventures, up until 1996, had been seed financed with relatively small sums - most commonly SMART awards that provided enough funding to build a prototype or conduct a trial of a new technology - but little else (see *footnote 3*).

A senior academic, in late 1995, who had worked for quite a number of years in a novel area of sugar biochemistry, approached UCLv. He had discovered a new class of small chemical compounds that seemed to play a major role in diabetes, obesity, pre-eclampsia and some types of cancer. The TLO, advised by UCLv, took out a suite of patents to protect the compounds and their possible uses.

It was clear that the sum of money required for developing the technology would be far larger than could be obtained from SMART, and UCLv worked intensively with the academic, contacting and arranging the project's presentation to a number of Venture Capital (VC) investors. In early 1997, after approximately 15 months of talking and negotiating, two London-based healthcare VCs invested a total of £6 million in the new company. From the outset, the company recruited top-flight people to manage the company.

This was the first time that UCLv had worked with faculty to raise venture capital finance and it was to prove to be a model for the type of company that UCL would spin-off in the future - UCLv had learned to think much more ambitiously.

(iii) Unifying technology transfer

In early 1997, the Technology Licensing Office and UCLv were combined into a single Technology Transfer Office, under a Director (the author) who directly reported to the Provost.

The two units continued to be managed and structured entirely separately, by their respective formations. UCLv reported directly

to the Provost, whereas the Licensing Office was part of the contract office that reported to UCL's Finance Committee through its own Board. This structure seemed logical since spin-offs (facilitated by UCLv) were in principle no different from any other potential licensee company. If they needed a Licence to develop UCL technology, they approached the Licensing Office and negotiated terms - supposedly on an arm's length basis.

However, though fine in theory, this structure came increasingly into question for a number of reasons.

- Both the Licensing Office and UCLv worked on the same technology base - there were occasions on which the two units competed for a specific technology (or worse, were unknowingly dealing with, and being played off by the same academic). Even when working together, there was tension between equity participation (favoured by UCLv) and licence income (the mainstay of the Licensing Office).

- However, more importantly, it became apparent that the 'business model' for the Licensing Office had very much more in common with the UCLv, than with the Research Contract Office. Both Licensing and Ventures - in comparison with most other non-academic departments within UCL - operated on a much longer time scale and had a clear remit to be cash-generative. Both were truly *investment centres* rather than *cost centres*. Until Stanford Rooke, the scale of potential payback from technology transfer had not been fully appreciated and pleas for further investment in technology licensing professions had been difficult to justify, given other research and teaching priorities.[8]

- The Hoeft Rademacher deal - which was seen by UCL as a model for the future - had required (but not always received) the integrated efforts and co-operation of the two units. It became apparent that

UCL could only provide this integrated approach if the two units were combined under a single roof, Director and name.

Under the new structure, the Director of UCL Ventures continued to report directly to the Provost (Chief Executive) of UCL, one of only two unit heads in UCL to do so.[9] As a result the Director's case for expansion of UCLv was considered to be at the top of the organization, as a strategic issue, rather than as beforehand, indirectly – through the Board (reporting to the Finance Committee). As a result, the number of staff at UCLv grew from three to eight 'Technology Transfer Project Managers' over a course of three years.

Enlarging UCLv had two effects:

- The team could specialize and take responsibility for developing technology transfer activity within specific areas (patches) of UCL. UCLv was split into two divisions: Biopharm (covering the medical school and life sciences) and Physical Sciences (including computing and engineering departments). All TT recruits had to have a background (preferably a Ph.D.) in the area in which they were responsible (most also had some professional qualification, such as an MBA or legal qualifications).

- The team could become much more proactive in every sense. Since individuals were responsible for making the most of their 'patches', they had an incentive to invest time into relationships with the best (most fruitful) faculty, and to ensure that IP was managed (to avoid premature disclosure). Project managers were encouraged to devote time to a small number of projects that – as judged by the project manager – had the greatest chance of pay-off. Indeed, good judgement became a key attribute of a project manager's success.

8. It is common, within most divisionalized organizations, for every division to defend itself as an investment, considering everyone else to be a cost.

Each manager began operating as he would within a business – choosing where to spend his/her scarce resources (time and patent budget) to greatest effect. Although members of the team constantly discussed projects with each other, the individual TT manager remained the only person with sufficient information of technology, market and faculty[10] to make an informed decision in relation to projects.

Dividing UCL into 'patches' also raised the question of whether the TT managers should be managed and financed centrally, in UCLv, or more locally in Departments. A number of larger institutes, within UCL, took the decision to place proportionally greater emphasis on TT activity and to finance in part – or all – the expense of their own TT manager. In two cases, an institute went as far as setting up subsidiary companies to manage the exploitation of IP.[11] UCLv was generally comfortable with these arrangements and happily seconded part-time staff to satellite operations, ensuring, however, at the same time, that senior TT staff oversaw their work and UCLv retained all authority for approving licensing deals.

Emphasis on spin-offs

Companies spun out of UCLv, from 1997 onwards were different from those spun out during the earlier years of UCLv. UCLv came to realize that it was the better-financed, externally managed companies that had the best chance of success. It became far more selective about companies it encouraged and to which it devoted time.

The success of SRL (flotation) and HRL (in fund-raising) became widely known amongst UCL faculty. A number of academics came forward, perhaps as a result of this, with new venture proposals (mostly biomedical). Many of these projects had great merit, but were

9. The other being another unusual operation – the Development (fundraising) Unit.

generally at an earlier stage than HRL technology – far too early for conventional venture capital investors (who tend to have a lower investment threshold of around £2-4 million).

UCLv, along with founding scientists, addressed this 'equity gap' issue by introducing unconventional sources of funding. In 1997 and 1998, four companies, able to bring both management skills *and* seed capital, were started in partnership with investors. All four of these companies grew very rapidly (going on to raise around £30 million of venture capital) and are still thriving. In return, however, these investors asked for a rather large share in the company (≈ 50 per cent). There is no doubting the value brought to the company – indeed, within a matter of months of initial investment, the companies had multiplied in value. Nevertheless, it was this very dramatic increase in value that caused UCL to wonder whether it could not have facilitated the same support on its own – thus retaining a greater share of equity in the spin-offs.

A major issue was clearly financial. Given the academic and research priorities (and its charitable status), UCL could not provide sizeable, high-risk capital seed funding from its own reserves. Consequently, it embarked upon raising its own seed fund from external sources, advancing well down the path towards producing a prospectus, when these plans were put 'on hold' by the announcement of two government schemes designed to stimulate

10. The decision to invest in any patenting or spin-off activity depends, of course, both on the strength of the IP position and the market. However, it also depends critically on the extent to which the inventors wish to be involved in the commercial exploitation of a technology. Very rarely may a TT manager even license a technology single-handedly. It has to be a team effort with the originators of the technology and, if we judge that an inventor has no interest, then UCLv will not progress to a patent. One recent USA study showed that 75 per cent of eventual licensees are found through the inventors.
11. In one case this exploitation company was part-owned by some key faculty in the institute. However, such ownership caused resentment among other researchers, who argued that it was quite wrong for one academic to benefit from another's inventions. As a result of this painful experience it has now become policy that any company set up to exploit technology arising from part of UCL must be wholly owned by UCL

exploitation from universities. These extremely generous schemes (aimed at filling the equity and management gaps respectively) were greeted enthusiastically and UCL was a major beneficiary of them both.

- The University Challenge Seed Fund (UCSF) was a scheme whereby universities could apply to set up their own seed fund. If successful, the government would provide 75 per cent of the seed fund. UCL applied for two such funds, totaling £8 million. One of these funds was aimed at biomedical technologies, the other communications and information technology.

- The Science Enterprise Fund aimed to provide entrepreneurial training for scientists (students and faculty) and to train MBA students and other experienced managers for the vagaries of running technology-based businesses (bringing, later, the two groups together to form rounded management teams). UCL entered a joint bid with London Business School and won £4.6 million towards a new centre.

These two schemes were greeted with great enthusiasm: by UCL and by the university sector as a whole. However, they also extended still further the business-creation role of the university, thereby raising a number of quite complex policy issues - many of which were entirely new to the university sector and are as yet unresolved.

(i) Pipeline licence agreements

Of all the issues relating to start-up companies (and to a lesser extent, licensing), the issue of IP pipelines causes the most problems. The issue arises when external investors seek a licence not for only existing IP but, in addition, for rights to future IP developed by the founders. The motivations for such requests are understandable.

- The existing IP may not be sufficiently strong to form a company (according to the valuation expected by university or founding faculty). One way to bolster the value is by including future research, especially if the founders' laboratories are well funded from public sources.

- The investors may fear that they will be 'held to ransom' by faculty over the next breakthrough invention (which may supplant the first). One way of preventing such a situation is securing first rights for these 'pipeline' inventions.

However, such provisions may cause major problems for universities and UCL is very cautious about this undertaking, unless the pipeline IP is extremely well defined by field, principal investigators and time. Problems arise when funding agencies object to private enterprises having rights to publicly or charitably funded work, and when IP, created by faculty who have no contact with the spin-off, is somehow caught up and 'encumbered' by the pipeline agreement.

(ii) Representing faculty

Faculty are accustomed to turning to university administrators for help and advice and – like any employee – would certainly expect to be 'insulated' from any legal action taken against the university as a result of a university activity. Consequently, temptation is great for a TT project manager to assume that, when setting up a company, he is negotiating and acting on behalf of both the university *and* the founding team of scientists.

It is, in fact, not right to do so. UCL now accepts the fact that there are three fundamental parties in any spin-off negotiation: inventors, investors and the university. Each 'party' has its own interests, and while the interests of faculty and university may coincide on the vast

majority of issues, there are potentially divisive issues that will surface later if not dealt with at the outset.

Consequently, UCLv always insists that faculty obtain separate legal representation from the outset. UCL recommends one particular legal firm that has now represented dozens of UCL faculty.

(iii) Extreme dilution of loyalty

Involvement by faculty in a spin-off can be absorbing, both in terms of emotional energy and time, and far more than in any licensing deal. Faculty own a piece of the company and often consider it to be their only chance for creating a retirement annuity! They may also find that involvement in the company can be (as one member of faculty recently put it) "far more entertaining than other aspects of university life". Moreover, they rationalize their actions by concluding that when they spend large amounts of time thinking and acting for the company, they take action in the best interests of the university – the justification being that the university also owns a substantial equity stake and thus stands to benefit. Such reasoning is valid up to a point (and can be tolerated for a time). It will not be long, however, before both teaching and research quality start to suffer. Yet, given the culture of individual freedom in universities (especially of senior faculty) universities find it extremely difficult to limit or scale back such involvement.

(iv) Licensing v. spin-offs

There is little doubt that far too many spin-off companies are being formed in the UK. This is partly a result of the availability of the University Challenge Seed Fund, but is equally for the following reasons:

- faculty who like the idea of starting their own business, or the extra control it gives over the exploitation of technology;
- technology transfer professionals, who find starting companies more 'fun' and involving than licensing (and sometimes easier, given the existence of in-house seed funds);
- universities who have read about other universities (like UCL) that have gained large sums from the sale of equity and would like to do the same;
- governments who like to count them.

There is always a case for a spin-off company, even when a large corporation can only realistically exploit the intended product. There are several occasions when UCL has failed to license scientific equipment or a new measurement service because the product is unproven or has not been reduced to practice. In such cases it may be worth while to develop or trial the product first and then license it – also, if there are no internal funds to pay for such development the inventors and university may be forced to set up a company in order to sell equity.

However, this is not the point. There is now much more emphasis on spin-off companies, and, as a result, not enough consideration is given to alternatives. Personal incentive and government intervention have distorted exploitation activity in favour of spin-offs, when often licensing may be the most effective and profitable outcome for the economy as a whole.

(v) Competing with customers

Universities are being increasingly encouraged to take an interest in industry and to generate more income from this source. They are

rightly seen as a powerful source of new ideas and as non-competing organizations to which companies may turn for their research needs. Though companies would be unwise to rely on such contract research, carried out in an environment of complete secrecy, it is reasonable to assume that the university will not metamorphose into a competitor. If universities, however, take exploitation too far in pursuit of revenue at the margin, then they surely become competitors to their customers and begin to lose their custom and trust.

(vi) Rewarding technology licensing staff

A key determinant for the success of spin-offs is the expertise of the Technology Transfer staff. As universities take a more proactive role in selection, creation and management of new ventures, they start to compete for the best staff – head to head with industry (who also value such deal-makers) and venture capitalists. A number of universities in the UK are now considering giving their technology transfer staff a stake in spin-offs, and the salaries paid to such staff are rising rapidly in line with the skills that are required to take the spin-offs one step further. Salaries begin to compete with senior academics and may cause serious tension within other administrative units.

(vii) Jeopardizing charitable status

When universities begin to engage in activities that are overtly making profit, many begin to question their charitable status. Universities have become quite clever in avoiding payment of taxes (e.g. setting up wholly-owned subsidiaries that covenant back profits). However there are other risks.

- Donors (especially corporate) may wonder whether the university needs their support.

- Companies are generally reasonably forgiving towards universities – few are willing to take action against universities for genuine mistakes. However, once universities themselves start becoming aggressive (enforcing IP rights, insisting on secrecy agreements) then companies may start treating universities no more leniently than they do each other.

(viii) Faculty taking equity in student spin-offs

There are a number of cases in which students have started their own businesses, based on ideas they have had or on research performed by them at UCL. Such activity is broadly encouraged and UCL does not usually take any equity whatsoever in such ventures. In a number of cases, however, a personal (university) tutor has given help and advice to a student and whether a member of faculty should be permitted to take equity in such ventures, in return for the assistance given, has sometimes been discussed. Some are vehemently opposed; others believe the suggestion is beyond the pail.

Conclusion

The IP issues faced by a university become more serious as the level of activity grows and as the emphasis moves towards exploitation and especially faculty involvement in spin-off companies. As with so many new initiatives, organizations must at first adopt liberal and flexible policies and keep a close eye on the pioneers, being willing to take risks, experiment and learn from mistakes. If policies are introduced too early, then they are likely to be rigid and harmful. Each case must be heard on its own merits and the Chief Executive of the organization must be closely involved in decision-

making to ensure speed and flexibility and to take courageous and imaginative decisions.

When and if the level of activity grows, it becomes impractical to monitor the activity of a very new company. However, the university should have become, at that point, experienced in issues relating to the activity and well positioned for putting into place a fair, efficient, robust and simple set of mechanisms to govern activity.

UCL has recently decided to constitute an IP Policy Committee. Now is probably the right time for such a body to be created - only now, after a decade of experience.

COMMENTS AFTER JEFFREY SKINNER'S PRESENTATION

by Didier Coulomb, French Ministry of Research

Introduction

The problem of intellectual property rights inside a university is in reality essentially a problem of technology transfer and commercialization of R&D results within the university.

In France, each university - and each research body - has its *own rules* on intellectual property rights and sometimes *no rules* at all. In addition, when there are rules, they are not always the same for contracts with different private enterprises. It is impossible to share the same regulations among all universities because they are independent and autonomous organizations. However, the Ministry can provide guidelines for them and try to convince them as much as possible that they must have a policy for intellectual property rights.

As mentioned by Mr Skinner, the number of contracts for research and their funding, received from both public and private sources, are also increasing in France.

In addition, we have new problems with the creation of enterprises using the research of the university. The law of innovation and research (adopted in July 1999) has permitted the researchers to participate in the creation of new enterprises based on their research results. It has allowed for the establishment of contracts between these new enterprises and the laboratory of the researcher. Since passing the law, we have doubled the number of spin-off enterprises based on public research. The only limiting factor to this is the obligation to have an authorization from the Commission of Deontology, and from the Administration Council of the University.

In fact, there are rarely problems, only in cases where no agreement can be reached as to whom intellectual property and the licences should be granted.

Mr Jeffrey Skinner asks many questions about spin-offs. We, however, did not ask these questions. We considered that we had total freedom to establish contracts, and good contracts in the interest of both the inventor and the university. In France, the royalties are shared between the researchers and the university. There are, however, several types of problems.

1. Risk capital: business imperatives, banks, etc. often require that the spin-off be the holder of the patent. This situation can pose a problem. If the spin-off is unsuccessful, then the university no longer has the patent and is unable to control the spin-off's future. Universities often prefer keeping part of the IPRs with royalties, instead of equities in spin-offs.

2. A patent's value is difficult to determine and universities often do not know how to negotiate it. Universities do not have expertise in this domain, which is surely the most important problem. We need professional services within universities who can manage this aspect of intellectual property.

3. Universities cannot manage too many equities in different enterprises because of the financial risk involved if they do not succeed. The president of the university may be held responsible.

We therefore attempt to separate public from private activities in French universities. According to the law on innovation and research, we offer the possibility to universities to more easily create subsidiary structures - private companies that have the responsibility and management of contracts, patents, and eventual equities in spin-

offs. Some examples of these already exist: Lyon, Valenciennes and INSA. We also offer the possibility for the universities to create special support structures for industrial and commercial activities (SAIC) which can have their own budget and staff. Nevertheless, they will remain within the university. In fact, there are many fiscal problems and we do have difficulties in applying this measure.

PART VI:
NOTES RELATING TO THE DISCUSSION OF THE WORKING GROUP SESSION

I. IN FINANCIAL MANAGEMENT OF UNIVERSITY-INDUSTRY LINKAGES – WHAT IS AT STAKE AND WHAT CAN BE DONE?

Chair: Mr Shabtay Dover, Hebrew University of Jerusalem

Questions to be addressed

- **Through what types of university-industry linkages are extra-budgetary funds predominantly generated within the participating universities?**

Some interesting possibilities arose:

- Sending undergraduate students to spend time in industry. The students are paid by the industry and some contribution is returned to the university.
- Conducting and running continuing (Engineering) education courses, both locally and over a distance.
- Offering specialist postgraduate programmes geared to the specific needs of certain industries.
- Technology transfer *via* the means discussed at large, namely providing incubation centres, patents, contract research etc.
- Consultancy services. This is very important within developing countries, owing to the lack of local expertise and skills. This keeps persons at the university while providing access to expertise, albeit at a lower level. If some high-level developments arise, their exploitation could be channelled through existing offices, such as at Warwick and UCL.

- **What financial incentives exist for motivating academic staff towards participation in joint university-industry projects and creating an entrepreneurial climate? Do the financial incentives perform their function or do they produce unintended effects?**

The following issues were discussed at length. A number of models were presented and although it was felt that no specific model could be 'universally' adopted, these can be used as working examples worth following. In all cases, incentives were felt necessary, and particularly in the face of strong market forces.

- The Hebrew University of Jerusalem renders an interesting example of a well-structured system. Incentives are given on two tiers:

  (i) salary incentive for promoting the submission of research proposals, once funds are awarded;
  (ii) if research produces products, *via* the commercialization thereof.

- It was felt that at some institutions and in some countries, the HUJ model would not be accepted, owing to the commitment to maintaining collegiate coherence. However, it is recognized that this failure is due to few young people being prepared to stay at universities when they could earn more money by practising outside. Hence market forces are forcing a re-think.

- Others simply rely on the fact that a good research record leads to rapid promotion and this is seen as the driving incentive.

- In summary: yes, incentives are desirable, particularly in the light of strong market forces.

▩ What types of capital funds are available or necessary in helping institutions to commercialize their products?

Three main sources of such capital funding were identified.

- In some cases the universities have provided capital funds to help commercialize products. The university takes the risk, but must reap the rewards as well (related to seed funding, etc.).
- In some cases, governments have realized longer-term benefits and have made it possible for the universities to bid for this money, or they have made it directly available to universities, on a tender basis. Hence, the government carries the risk (related to seed funding, etc.).
- The university could borrow money, provided it is allowed. This can be achieved by setting up operations such as training and conference centres that can be used by the university or other bodies. If carefully controlled, it can be a big source of income, provided there is a solid business plan.
- It was agreed that the university could not expect much by way of donations to be used for this purpose.

▩ What instruments are in place, or necessary, to allow a proper costing of services, in particular in the R&D domain?

Here it was agreed that it is best for the universities to have some independent business operation managing the activity in a professional and businesslike way. Some aspects arose showing that overhead costing must be carefully determined.

- It is better to get someone professional outside the university to do a proper costing of overheads. In this way the university community may well accept this overhead recovery costing, rather than have it imposed by the administration.

- Some countries are trying to develop standardized overhead costing to be used by all.

- The need for differentiated overhead recovery was identified. This will vary from country to country and organization to organization.

Finally, Michael Shattock drew to the group's attention that the value of the arts and humanities should not be overlooked. The research contribution of these areas does influence our longer-term thinking. We have concentrated on the short-term technology issues and have ignored the longer term.

II. IN PERSONNEL MANAGEMENT OF UNIVERSITY-INDUSTRY LINKAGES – WHAT IS AT STAKE AND WHAT CAN BE DONE?

Chair: Mr Esteva Maraboto, UNAM Mexico

Questions to be addressed

- **As part of an overall policy to develop university-industry linkages, are there any particular staff policies in place to identify and make available necessary competences within the institutions for the development of university-industry linkages?**

This discussion focused on staff policies with regard to different types of personnel involved:

- managers of university-industry relations at the grass roots, such as individual academic staff, team leaders or heads of department;
- professional administrators such as technology transfer officials, heads of continuing education offices or heads of commercial interfaces;
- top-level academic leaders who are in charge of policy-making and implementation of initiatives in the area of university-industry linkages.

These different clientele have different training needs, which necessitate specific types of support systems for performing their assigned tasks.

Universities tend to be relatively passive in the identification of necessary competences and in defining necessary staff development measures. They generally tend to rely on hiring specific individuals, usually staff with experience in industry, who will be in charge of a specific task, such as technology-transfer services.

The National Autonomous University of Mexico (UNAM) related a strategy concerned with modifying the general attitude towards mission-oriented research and technology by setting up a new interface during the mid eighties - the Centre for Technological Innovation (CIT) - whose function was both to provide services to the basic unit for technology transfer and to act as an academic unit for research and training in this area. CIT offered in-house training in areas relating to technological innovation to all those in charge of technology transfer. CIT also helped to define three policy instruments, one of which was concerned with a change in the evaluation criteria of staff involved in technology transfer, with rules both for the granting of intellectual property and for the distribution of revenues generated through licensing and royalties. The strategy pursued at UNAM is one that aimed to change the organizational culture through the above-mentioned policy instruments, the creation of the interface itself, as well as through the in-house training which it provided.

The discussion focused on a number of issues, among which were the following:

- how to establish a relationship of trust between interface officials and academic staff within the basic units?

- what types of skills/competences needed for the management of university-industry relations should be outsourced and which should be available in-house?

- who has the competence and is going to judge and choose the outside partners?

- is it acceptable to the academic community that professional managers run interfaces or should they be run by academics to avoid a clash in culture?

- through what mechanism may a flow of communication be ensured between professional managers and academic staff within the basic units?

- **What incentives exist, other than financial, to motivate staff to participate in joint university-industry projects and to create an entrepreneurial climate? Do these incentives perform their function or do they produce unintended effects?**

The discussion on staff motivation focused by and large on necessary changes in promotion criteria, given the fact that most promotion systems focus exclusively on the number and sometimes on the quality of publications. Commitment to university-industry may be, but is not necessarily, counterproductive for a researcher's career in academia.

Several institutions, among which UNAM and BITS, mentioned that they had operated a change in the promotion criteria, also taking into account community services or technology transfer. Such changes do often represent, however, a change in culture and might take a long time to be accepted by the academic community. In the case of UNAM it took four years to reach an agreement on such a change and to the way in which commitment to university-industry linkages should be valued. At BITS, however, engagement in university-industry linkages is seen as part of the task to be performed by academic staff and, as such, has always been part of the evaluation.

The discussion focused on the following questions:

- what changes in promotion procedures are necessary to take into account commitment to the development of university-industry linkages?

- who is competent to judge staff performance with regard to their capacity in identifying a technological problem, solution and/or prototype; doing rigorous testing, etc., in these domains, if it is not peers from industry?

A necessary motivation system for university-industry linkages is support from institutional policy-makers. If the head of an institution appreciates as valuable, contributions of individuals to the development of university-industry linkages, for instance during a public speech, this may have a strong effect on personal and collective motivation systems.

▩ What policies and instruments are in place to avoid possible negative effects of university-industry relations such as barriers to open communication, restrictions on publications and internal fragmentation and conflict?

The institutions represented in the working group mentioned that negative effects of university-industry linkages were not seen to be very important. It was said that open communication on research projects was relatively rare anyhow and that university-industry collaboration would not have an important impact. Diversion of energy of academic staff with opportunities for collaboration with industry was perceived as a real danger. Universities do generally apply the rule that a staff member is allowed to spend *one* day in industry. However, some universities said that if they applied this rule too strictly, staff would leave the institution.

The discussion focused on the following two questions:

- how is it possible to create transparency on staff involvement within a university-industry linkage?
- is it desirable to invite staff from industry to the university campus for collaboration with research teams?

How to create transparency of staff involvement in university-industry linkages was a major issue in the discussion. Many institutions have set up rules, obliging staff to disclose their consultancy projects to their heads of department. Their role is crucial for they must verify that staff do not neglect their duties, in particular with regard to teaching obligations. However, participants also mentioned that such transparency is part of an existing culture and that in many places the role of the head of department needs to be changed to enable heads of department to perform this function of control.

Participants also insisted that it was not desirable to invite industry staff to collaborate in university research teams. Experience has shown in some cases that such staff tend to impose their values and working culture on university teams and that this attitude favours conflicts.

III. NOTES RELATING TO THE PANEL DISCUSSION. HOW TO CREATE AN ENABLING ENVIRONMENT FOR THE STIMULATION OF UNIVERSITY-INDUSTRY LINKAGES?

Participants

Gudmund Hernes	IIEP Director, Chair
Ary Plonski	University of São Paulo, Brazil
G.S. Kochhar	University of the West Indies
Trond Fevolden	Ministry of Education, Research and Church Affairs, Norway
Daniel Malkin	OECD

Objective

The objective of this panel discussion was to draw conclusions from a limited number of country experiences on the role that is, or could be, played by governments to facilitate university-industry linkages. Broadly speaking, the role of government is twofold:

(i) developing a legislative framework which supports or at least does not restrict collaborative activities between universities and industry;

(ii) establishing financial incentives for both universities and industry, such as tax alleviation or matching funds for joint projects.

It was decided that the discussion should focus on three aspects, i.e. legal framework for intellectual property rights, financial autonomy, and promotion criteria and practices.

The following two questions were addressed in the panel discussion.

- **How does the national legal framework in the areas of financial autonomy, rules for the promotion of staff and intellectual property rights affect the development of university-industry linkages at your institution or in your country?**

All speakers mentioned that a national framework for the protection of intellectual property rights is of utmost importance. In Brazil, such a law was passed in 1966, whereas in the West Indies (where 14 countries had to agree) such a law was only passed in 1998. More recently, there are discussions on the ownership of rights for intellectual property that is gained from R&D sponsored by Brazilian government agencies. In Norway, IPR rights always go directly to the inventor, which creates a direct incentive to push inventions into the economy. As a consequence, rules and regulations on intellectual property rights are quite diverse from one country to the other. They are often also taken in default of any other decisions.

The University of the West Indies has recently passed an internal regulation that governs the distribution of income from IPR. Fifty per cent of net income goes to the inventor, 20 per cent to the department/institute and 30 per cent to the originating campus.

With regard to financial incentives, governments in both countries are very active. For example in Brazil, there are several schemes whereby local industry has been given tax incentives to spend on R&D, especially within the framework of collaborative projects with

not-for-profit institutions. In the West Indies, collaboration between multinationals and the University of the West Indies has proved to be difficult, due to the fact that multinationals tend to cover their R&D needs with important technology from their home department. Since recently, the Government of Trinidad and Tobago obliges multinationals to put money into an R&D fund from which the University of the West Indies can draw.

With regard to the setting of new promotion criteria, both institutional representatives stated that a change in the rules and procedures are within the competences of the institution, but that it is more frequently internal resistance that prevents such changes, rather than obstacles pertaining to the legislative framework. It is often the adoption of a detailed methodology and decisions on the weighing of activities, which entail lengthy discussions.

It was also mentioned that in Norway, institutions of higher education have the possibility to differentiate salaries of academic staff. This has not yet happened, however, because it is not compatible with the prevailing university culture and the Norwegian strong sense of equality.

- **In the light of persisting obstacles, what policies and measures would be necessary in these areas to facilitate university-industry linkages?**

Mr Daniel Malkin, Director of the OECD Division of Science, Technology and Industry (DSTI), who gave an account of different activities conducted within his division, closed the panel discussion. One of the focal points is the identification of obstacles that prevent university-industry collaboration, such as conflicts over IPR, statutes of civil servants and absence of portable pension schemes which hinder staff mobility between industry and the science system. An

analysis of obstacles to the creation of spin-offs – e.g. lack of financial support and regulatory mechanisms – is also part of the ongoing research. Currently, his Division is very much involved in an attempt to develop a methodology for the benchmarking of university-industry partnerships, with a view to preparing a tool for the monitoring of the effectiveness of such relations. Indicators will be developed with regard to co-patenting, co-publications and spin-off creations. Such a methodology will allow governments to identify where they stand in the development of some crucial dimensions of research-related university-industry partnerships.

APPENDICES

APPENDIX 1. PROGRAMME

1 June 2000

9h00-10h30 **Opening statements. Trends in university-industry linkages: what are the challenges ahead?**

Speakers: Gudmund Hernes and Michaela Martin, IIEP

11h00-13h00 **In what way do the changing university-industry relations affect the academic activities within higher education institutions?**

Chair: S. Venkateswaran, BITS Pilani, India

Speaker: Ary Plonski, University of São Paulo, Brazil

Discussant: Carl Lindberg, Ministry of Education and Science, Sweden

Discussion and comparing notes

14h15-14h30 Audiovisual on IIEP

14h30-16h00 **In what way do the changing university-industry relations affect the management of higher education institutions?**

Chair: Bikas C. Sanyal, IIEP

Speaker: Michael Shattock, Institute of Education, University of London, UK.

Discussant: Trond Fevolden, Ministry of Education, Research and Church Affairs, Norway

Discussion and comparing notes

16h30-18h00 **Organizational responses: the management of interfaces**

Chair: Lotte Jaspers, University of Amsterdam, Netherlands
Speaker: Moshe Vigdor, Hebrew University of Jerusalem, Israel
Discussant: Knud Larsen, Ministry of Research, Denmark
Discussion and comparing notes

2 June 2000

9h00-10h30 **Intellectual property rights and rules on conflicts of interests**

Chair: Bénédicte Callan, OECD
Speaker: Jeffrey Skinner, UCL Ventures, UK.
Discussant: Didier Coulomb, Ministère de l'Éducation nationale de la Recherche et de la Technologie, France
Discussion and comparing notes

11h00-13h00 **Working groups: what is at stake and what can be done?**

Group 1: **In financial management**
Chair: Shabtay Dover, Hebrew University, Jerusalem, Israel
Rapporteur: C. F. Landy, University of the Witwatersrand, South Africa

Group 2: **In staff management**
Chair: José Antonio Esteva, UNAM, Mexico
Rapporteur: Tony Marjoram, UNISPAR/UNESCO

14h00–15h30 **Working group reporting on recommendations**

Chair: Michaela Martin, IIEP

16h00–17h30 **Panel discussion for national and institutional policy-makers:**
How to create an enabling environment for university-industry linkages?

Chair: Gudmund Hernes, IIEP
G. S. Kochhar, University of the West Indies
Ary Plonski, University of São Paulo, Brazil
Trond Fevolden, Ministry of Education, Research and Church Affairs, Norway
Daniel Malkin, OECD
Discussion

17h30–18h00 **Concluding summary of proceedings: where do we go from here?**

Chair: Gudmund Hernes, IIEP

APPENDIX 2. LIST OF PARTICIPANTS

I. Africa

South Africa

Mr C.F. Landy
Head of the Department of Electrical Engineering
University of Witwatersrand
Johannesburg, South Africa

II. Asia

India

Mr V.S. Rao
Dean
Birla Institute of Technology and Science, Pilani
Rajasthan, India

Mr Venkateswaran
Birla Institute of Technology and Science, Pilani
Rajasthan, India

III. Caribbean

Trinidad and Tobago

Mr Clement Imbert
The University of the West Indies
Faculty of Engineering
St. Augustine
Trinidad and Tobago

Mr G.S. Kochar
Dean, The University of the West Indies
Faculty of Engineering
St. Augustine, Trinidad and Tobago

IV. Europe

Denmark

Mr Knud Larsen
Danish Ministry of Research
Copenhagen, Denmark

France

Mr Didier Coulomb
Sous-Directeur de l'Innovation et du Développement
Technologique
Ministry of Research
Paris, France

Israel

Mr Shabtay Dover
Director, European Office
Authority for Research & Development
The Hebrew University of Jerusalem
Jerusalem, Israel

Mr Moshe Vigdor
Vice President and Director General
The Hebrew University of Jerusalem
Jerusalem, Israel

The Netherlands

Ms Lotte Jaspers
University of Amsterdam
Spui, The Netherlands

Norway

Mr Trond Fevolden
Director General
Ministry of Education, Research and Church Affairs
Oslo, Norway

Sweden

Mr Carl Lindberg
Director General
Ministry of Education and Science
Stockholm, Sweden

Turkey

Mr Okyay Kaynak
Bogaziçi University, Faculty of Engineering
UNESCO Chair on Mechatronics
Istanbul, Turkey

United Kingdom

Mr Michael Shattock
Institute of Education
University of London
London, United Kingdom

Mr Jeffrey Skinner
Director
UCL Ventures at University College London
London, United Kingdom

V. Latin America

Brazil

Mr Guilherme Ary Plonski
Escola Politécnica da Universidade de São Paulo
São Paulo, Brazil

Mexico

Mr José Antonio Esteva
UNAM, Mexico

VI. International organizations

UNESCO

Mr P. Falzon
BER/BKS
UNESCO

Ms M-L. Kearney
HEP/CHE
UNESCO

Mr Tony Marjoram
SC/EST
UNESCO UNISPAR Programme
Paris, France

Mr Francisco Seddoh
HEP/IUC
UNESCO
Paris, France

Mr M. El Tayeb
SC/PAO
UNESCO

VII. IIEP staff

Mr Gudmund Hernes
Director, IIEP

Mr N.V. Varghese
Programme Specialist

Ms Michaela Martin
Programme Specialist

Mr David Atchoarena
Programme Specialist

Mr Bikas C. SANYAL
Special Adviser

Others

Ms Bénédicte Callan
Science and Technology Policy Division
OECD
Paris, France

Mr Daniel Malkin
Head, Science & Technology Policy Division
OECD
Paris, France

Mr Richard Yelland
OECD/IMHE
Paris, France

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Director, Lang Education, Kuala Lumpur, Malaysia.

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Chief, Training Policy and Employability Unit, Skills Development Department, International Labour Office (ILO) Geneva, Switzerland.
Eduardo A. Doryan
Vice-President, Human Development Network (HDN), The World Bank, Washington D.C., USA.
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Professor, University of Paris I, Panthéon-Sorbonne, Paris, France.

Inquiries about the Institute should be addressed to:
The Office of the Director, International Institute for Educational Planning,
7-9 rue Eugène-Delacroix, 75116 Paris, France.

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The book

Within the context of knowledge-intensive societies, university-industry linkages have become very prominent on the agenda of higher education policy-making, both at the national and institutional levels. Governments are increasingly acknowledging the importance of higher education institutions as strategic actors in national and regional economic development, given their potential to upgrade knowledge within the labour force and to contribute to product and process innovation through technology transfer. As a result of increased financial stringency, higher education institutions themselves have become very keen on developing relations with industry and business.

The structural problems faced by higher education institutions in developing and sustaining linkages with business and industry are similar in most countries. Yet the responses to these problems vary from one country to the other and also among institutions. In order to explore varying institutional responses to the structural problems involved in university-industry linkages, the IIEP conducted case-study research from 1997 to 1999, after which was organized a Policy Forum in order to share and validate the insights gained during the previous research phase. This books sets forth the conclusions of the Forum.

Management of university-industry linkages

The authors

***Gudmund Hernes**, former Minister of Education, Research and Ecclesiastical Affairs and then Minister of Health for Norway, is the present Director of IIEP. He has a PhD in Sociology from Johns Hopkins University, has been a Professor of Sociology at the Universities of Bergen and Oslo; he has also been a Fellow at Center for Advanced Study in the Behavioral Sciences (Stanford), and Visiting Professor at Harvard University. He has authored or edited nearly 40 books and has served on the editorial boards of many journals, including The American Journal of Sociology.*

***Michaela Martin** is a Programme Specialist at IIEP. An expert in policy-making, planning and management of higher education at the system and institutional level, she is in charge of a research project on the management of university-industry relations.*

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